COSEWIC
Assessment and Status Report

on the

Piping Plover
Charadrius melodus

circumcinctus subspecies (*Charadrius melodus circumcinctus*)
melodus subspecies (*Charadrius melodus melodus*)

in Canada

ENDANGERED
2013

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

COSEWIC. 2013. COSEWIC assessment and status report on the Piping Plover *circumcinctus* subspecies (*Charadrius melodus circumcinctus*) and the *melodus* subspecies (*Charadrius melodus melodus*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xiv + 39 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm).

Previous report(s):

COSEWIC. 2001. COSEWIC assessment and update status report on the Piping Plover *circumcinctus* subspecies (*Charadrius melodus circumcinctus*) and the *melodus* subspecies (*Charadrius melodus melodus*), in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 33 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Boyne, A. 2001. Update COSEWIC status report on the Piping Plover *circumcinctus* subspecies (*Charadrius melodus circumcinctus*) and the *melodus* subspecies (*Charadrius melodus melodus*) in Canada, *in* COSEWIC assessment and update status report on the Piping Plover *circumcinctus* subspecies (*Charadrius melodus circumcinctus*) and the *melodus* subspecies (*Charadrius melodus melodus*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-33 pp.

Haig, S. 1985. Update COSEWIC status report on the Piping Plover *Charadrius melodus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 36 pp.

Bell, F.H. 1978. COSEWIC status report on the Piping Plover *Charadrius melodus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 45 pp.

Production note:
COSEWIC acknowledges Nyree Sharp for writing the status report on the Piping Plover, *Charadrius melodus*, *circumcinctus* and *melodus* subspecies, prepared under contract with Environment Canada. This report was overseen and edited by Marty Leonard, Co-chair of the COSEWIC Bird Specialist Subcommittee.

For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment Canada
Ottawa, ON
K1A 0H3

Tel.: 819-953-3215
Fax: 819-994-3684
E-mail: COSEWIC/COSEPAC@ec.gc.ca
http://www.cosewic.gc.ca

Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur le Pluvier siffleur de la sous-espèce *circumcinctus* (*Charadrius melodus circumcinctus*) et de la sous-espèce *melodus* (*Charadrius melodus melodus*) au Canada.

Cover illustration/photo:
Piping Plover — Line drawing by Judie Shore with permission.

©Her Majesty the Queen in Right of Canada, 2014.
Catalogue No. CW69-14/193-2014E-PDF
ISBN 978-1-100-23550-9

Recycled paper

COSEWIC
Assessment Summary

Assessment Summary – November 2013

Common name
Piping Plover - *circumcinctus* subspecies

Scientific name
Charadrius melodus circumcinctus

Status
Endangered

Reason for designation
The interior subspecies of this shorebird is projected to decline over the longer term, particularly if concerted conservation efforts are relaxed. Overall numbers remain low and adult survival has been poor over the last decade. Threats from predation, human disturbance, and declines in habitat extent and quality continue.

Occurrence
Alberta, Saskatchewan, Manitoba, Ontario

Status history
The species was considered a single unit and designated Threatened in April 1978. Status re-examined and designated Endangered in April 1985. In May 2001, the species was re-examined and split into two groups according to subspecies. The *circumcinctus* subspecies was designated Endangered in May 2001. Status re-examined and confirmed in November 2013.

Assessment Summary – November 2013

Common name
Piping Plover - *melodus* subspecies

Scientific name
Charadrius melodus melodus

Status
Endangered

Reason for designation
Numbers of the eastern subspecies of this small shorebird remain extremely low and the population continues to decline, despite concerted conservation efforts. Threats from predation, human disturbance, and declines in habitat extent and quality also continue.

Occurrence
Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador

Status history
The species was considered a single unit and designated Threatened in April 1978. Status re-examined and designated Endangered in April 1985. In May 2001, the species was re-examined and split into two groups according to subspecies. The *melodus* subspecies was designated Endangered in May 2001 and November 2013.

COSEWIC
Executive Summary

Piping Plover
Charadrius melodus

circumcinctus subspecies (*Charadrius melodus circumcinctus*)
melodus subspecies (*Charadrius melodus melodus*)

Wildlife Species Description and Significance

The Piping Plover is a small shorebird that is found only in North America. It has a pale, sand-coloured back, short stout bill and orange legs. During the breeding season, it also has a single black band across the breast, another black band across the forehead between the eyes, and a distinctive black tip on the orange bill. There are two subspecies: the interior subspecies breeds on the Canadian prairies, the US Great Plains, and in the Great Lakes region, and the eastern subspecies breeds along the Atlantic Coast of Canada and the US.

Over one third of the global breeding population of Piping Plovers is found in Canada, and over one half of the breeding range. Piping Plovers have been the focus of extensive research, conservation and recovery efforts over the last 50 years.

Distribution

Individuals of the interior subspecies breed in Alberta, Saskatchewan, Manitoba and Ontario (Lake of the Woods and Great Lakes regions), as well as in the Great Plains and Great Lakes regions of the US. Individuals of the eastern subspecies breed in the Gulf of St. Lawrence: on the Magdalen Islands of Quebec and on the coasts of New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador, and the French islands of Saint Pierre and Miquelon. They are also found along the Atlantic coast beaches of the US. Piping Plovers winter along the Gulf coast of the US and Mexico, southern Atlantic US coast, and the Caribbean, including the Bahamas and Cuba. While there is overlap among breeding populations, most Prairie/Great Plains birds winter along the coast of the Gulf of Mexico, most Great Lakes birds on the Atlantic coast and Florida, and most Atlantic breeders on the Atlantic coast and the Caribbean.

Habitat

Across its breeding range, the Piping Plover nests on wide sandy beaches with little vegetation and a mix of substrates such as pebbles, gravel, shells and sticks. On the prairies, Piping Plovers are most closely associated with alkali lakes, and are also found at reservoirs and freshwater lakes. In the Canadian Great Lakes and at Lake of the Woods, Ontario, Piping Plovers nest on sand and pebble beaches of freshwater dune formations on barrier islands, peninsulas or shorelines of large lakes. On the Atlantic coast, they are associated with sandy beaches on barrier islands, oceanfronts, bays and sand bars. The beaches used by Piping Plovers, on both breeding and wintering grounds, are also of great value to human populations, so habitat has been lost to or degraded by development, resource extraction, recreation and other disturbances.

Biology

Adult Piping Plovers arrive on breeding grounds in Canada from mid-April to mid-May, often returning to the same nesting area in consecutive years. Nests are made by males, and are simple depressions or scrapes in the sand, often lined with pebbles, shells or driftwood for camouflage. Four eggs are laid, and hatch after about 28 days. Both parents incubate the eggs and tend the chicks. Chicks are able to fly 18–35 days after hatching. Fledging success is highly variable and on average only one to two young per clutch fledge. Subadult survival rates are estimated as 0.53 to 0.57 (but as low as 0.34 in southern Nova Scotia), and estimated adult survival rates range from 0.73 to 0.80.

Population Sizes and Trends

Counts from the most recent International Piping Plover Census in 2011 indicate an overall Canadian population of approximately 1439 adults, of which 1033 individuals are of the interior subspecies and 406 are of the eastern subspecies. The count for the interior subspecies, in particular, may be an underestimate because flooding in 2011 reduced available habitat and forced nesting pairs into areas not included in the census. There has, however, been consistent flooding since the last census, so some reduction in population size is expected. The more precise annual surveys available for the eastern subspecies indicate a population of 389 adults in 2013.

Information on population trends for the interior subspecies from the International Piping Plover Census shows a long-term (1991–2011) decline of 22.9% and a short-term decline of 12% over the most recent 10 years (2001–2011) or approximately three generations.

Information on population trends for the eastern subspecies from annual surveys shows a non-significant decline of 13% on the long-term (1991–2013) and a significant decline of 23% over the most recent 10 years (2003–2013) or approximately three generations.

Threats and Limiting Factors

The key threats to Piping Plovers are predation (primarily of eggs and chicks), human disturbance, and habitat loss or degradation. Some natural predators have increased with increasing human presence, and domestic and feral animals also prey on Piping Plovers. Human disturbance has direct effects on Piping Plovers through the destruction of eggs or nests, and several indirect effects such as distracting birds from nesting and feeding activities, and leaving tire tracks on breeding beaches that make feeding more difficult for the plovers and can trap chicks. Human activities, including development, recreation, and resource extraction, reduce the amount and quality of habitat available to the Piping Plover on breeding grounds and wintering grounds. Climate change poses a growing threat, particularly on coastal breeding and wintering grounds, where an increase in severe storms and rising sea levels are expected to reduce the amount of available habitat. Drier conditions and an increase in severe storms pose a threat to habitat and populations on the Prairies as well. Other threats to the Piping Plover include grazing livestock, extreme high tides, hurricanes (during migration and on the wintering grounds), pollution and oil spills.

Protection, Status, and Ranks

The Piping Plover was first designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Threatened in Canada in 1978. In 1985, the species was re-examined and designated as Endangered. In 2001, the species was reassessed as two subspecies, both of which were designated Endangered and are now listed as such under Canada's *Species at Risk Act*. The Piping Plover is also protected under the *Canada National Parks Act* on breeding grounds within National Parks. It is protected under provincial acts throughout its range except for Prince Edward Island.

In the US, the Piping Plover is listed as Endangered on the Great Lakes and Threatened elsewhere. It is listed as Near Threatened on the IUCN Red List of Threatened Species; however, that assessment, dated 2008, was contingent on a continuing upward trend in overall population size. The Piping Plover is ranked as "at risk" by the General Status of Wild Species, in Canada as a whole and in all provinces across its range. NatureServe lists the global rank of Piping Plover as Vulnerable (as of January 2001, last reviewed in December 2004), the national rank in Canada as Imperilled (as of September 2011), and the provincial ranks as Vulnerable (SK), Imperilled (AB, NB) and Critically Imperilled (MB, ON, QC, NL, NS, PE).

TECHNICAL SUMMARY - *circumcinctus* subspecies

Charadrius melodus circumcinctus

Piping Plover *circumcinctus* subspecies — Pluvier siffleur de la sous-espèce *circumcinctus*

Range of occurrence in Canada (province/territory/ocean): AB, SK, MB, ON

Demographic Information

Generation time (based on recent studies; see Life Cycle and Reproduction section)	3 - 4 yrs
Is there an observed continuing decline in number of mature individuals?	Yes
Estimated percent of continuing decline in total number of mature individuals within 2 generations	N/A
Observed percent decline in total number of mature individuals over the last 3 generations. Based on a linear regression using the rate of decline for counts from the International Piping Plover Census over the entire time series (1991 - 2011) and then applied to the last 10-year period	12.2%
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations]. Decline likely to continue if low productivity and adult survivorship persist	Unknown, but decline likely to continue
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future. Decline likely to continue if low productivity and adult survivorship persist	Unknown, but decline likely to continue
Are the causes of the decline clearly reversible and understood and ceased?	N/A
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence	555 000 km²
Index of area of occupancy (IAO) The IAO cannot be calculated because the spatial distribution of breeding pairs is unknown	Unknown
Is the total population severely fragmented?	No
Number of locations	Unknown, but >10
Is there an observed, projected continuing decline in extent of occurrence?	No – increasing because of Great Lakes birds
Is there an observed, projected continuing decline in index of area of occupancy?	Yes
Is there a continuing decline in number of populations?	N/A
Is there a continuing decline in number of locations?	Unknown, but possible if decline continues
Is there an observed, projected continuing decline in quality of habitat?	Yes

Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals based on 2011 International Piping Plover Census

Population	N Mature Individuals
AB	244
SK	771
MB	2
ON	16
Total	1033

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years]. Preliminary modelling efforts suggest declines into the future	Not available

Threats (actual or imminent, to populations or habitats)

Predation, human disturbance, habitat loss, livestock presence

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? US Great Lakes breeding population is listed as Endangered; all other US breeding populations are Threatened.	
Is immigration known or possible?	Yes
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely?	Possible, particularly in the Great Lakes population, but not likely to be significant given the status of outside populations

Status History

The species was considered a single unit and designated Threatened in April 1978. Status re-examined and designated Endangered in April 1985. In May 2001, the species was re-examined and split into two groups according to subspecies. The *circumcinctus* subspecies was designated Endangered in May 2001. Status re-examined and confirmed in November 2013.

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Endangered	C2a(ii)

Reasons for designation:
The interior subspecies of this shorebird is projected to decline over the longer term, particularly if concerted conservation efforts are relaxed. Overall, numbers remain low and adult survival has been poor over the last decade. Threats from predation, human disturbance, and declines in habitat extent and quality continue.

Applicability of Criteria

Criterion A: Does not meet criterion. Population has declined over the last 10 years or approximately three generations but the decline is below the threshold.
Criterion B: Does not meet criterion. Extent of occurrence is above the threshold and index of area of occupancy could not be calculated, so is unknown.
Criterion C: Meets Endangered C2a(ii) because there are fewer than 2500 mature individuals and a projected decline in the numbers of mature individuals with one subpopulation having more than 95% of all mature individuals.
Criterion D: Does not meet criterion. Nearly meets Threatened D1 because current population is estimated at approximately 1033 mature individuals, the number of locations is above the threshold, and the IAO is unknown.
Criterion E: Not available.

TECHNICAL SUMMARY - *melodus* subspecies

Charadrius melodus melodus

Piping Plover *melodus* subspecies — Pluvier siffleur de la sous-espèce *melodus*

Range of occurrence in Canada (province/territory/ocean): QC, NB, PE, NS, NL

Demographic Information

Generation time (based on recent studies; see Life Cycle and Reproduction section)	3 - 4 yrs
Is there an observed continuing decline in number of mature individuals?	Yes
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	N/A
Observed percent reduction in total number of mature individuals over the last three generations Linear regression on annual survey counts shows a non-significant decline of 13% over the long term (1991-2013) and a significant decline of 23.3% over the last 10 years or approximately three generations	23.3%
[Projected or suspected] percent reduction in total number of mature individuals over the next [10 years, or 3 generations].	Unknown, but decline likely to continue
[Observed, estimated, inferred, or suspected] percent reduction in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown, but decline likely to continue
Are the causes of the decline clearly reversible and understood and ceased?	No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence Extent of occurrence with (298 500 km²) and without (217 600 km²) the inclusion of site in northeastern Newfoundland, where a single bird was recorded in 2012 and a pair bred in 2013. It is not clear that there will be continuous use of this site, so both values of EO have been included.	217 600 - 298 500 km²
Index of area of occupancy (IAO)	424 km²
Is the total population severely fragmented?	No
Number of locations	Unknown, but >10
Is there an observed, or projected continuing decline in extent of occurrence?	No
Is there an observed, or projected continuing decline in index of area of occupancy?	Yes
Is there a continuing decline in number of populations?	No
Is there a continuing decline in number of locations?	Unknown, but possible if decline continues
Is there an observed, projected continuing decline in area, extent and quality of habitat?	Yes
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations?	No

Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals in 2013 from Annual Survey year-end counts

Population	N Mature Individuals
QC	60
NB	108
PE	63
NS	107
NL	51
Total	389

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	not available

Threats (actual or imminent, to populations or habitats)

Predation, human disturbance, habitat loss, climate change

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? US breeding populations are listed as Threatened.	
Is immigration known or possible?	Yes - possible but very restricted
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely?	Unlikely because of low rate of exchange

Status History

The species was considered a single unit and designated Threatened in April 1978. Status re-examined and designated Endangered in April 1985. In May 2001, the species was re-examined and split into two groups according to subspecies. The *melodus* subspecies was designated Endangered in May 2001 and November 2013.

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Endangered	C2a(i)

Reasons for designation:
Numbers of the eastern subspecies of this small shorebird remain extremely low and the population continues to decline, despite concerted conservation efforts. Threats from predation, human disturbance, and declines in habitat extent and quality also continue.

Applicability of Criteria

Criterion A: Does not meet criterion. Population has declined over the last 10 years or approximately three generations but the decline is below the threshold.
Criterion B: Does not meet criterion. EO is above the thresholds. IAO is below threshold for Endangered, but population is not severely fragmented and the number of locations is above the threshold. It also does not show extreme fluctuations.
Criterion C: Meets Endangered C2a(i) because the number of mature individuals is less than 2500, there is a projected continuing decline in the number of mature individuals and no population is estimated to contain more than 250 mature individuals.
Criterion D: Meets Threatened D1 since the population is estimated to have less than 1000 mature individuals but more than 250.
Criterion E: Not available.

PREFACE

This report is an update of the previous status report (Boyne in press) that was prepared for the 2001 assessment of the Piping Plover, but not published. There have been three International Piping Plover censuses (2001, 2006 and 2011) since the last assessment, and annual surveys across the range of the *melodus* (eastern) subspecies have continued. Also, a small breeding population of the *circumcinctus* (interior) subspecies has been established on the Ontario Great Lakes (and sporadic breeding at Lake of the Woods) since the last assessment. Studies of recaptures of banded eastern birds have also taken place since 2001. The species is now considered management-dependent throughout most of its breeding range in Canada. Increasingly, research is being focused on the wintering grounds of the species.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2013)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment Canada | Environnement Canada

Canadian Wildlife Service | Service canadien de la faune

Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Piping Plover
Charadrius melodus

circumcinctus subspecies (*Charadrius melodus circumcinctus*)
melodus subspecies (*Charadrius melodus melodus*)

in Canada

2013

TABLE OF CONTENTS

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE 4
Name and Classification 4
Morphological Description 4
Population Spatial Structure and Variability 6
Designatable Units 7
Special Significance 7
DISTRIBUTION 7
Global Range 7
Canadian Range 8
Search Effort 11
HABITAT 12
Habitat Requirements 12
Habitat Trends 13
BIOLOGY 15
Life Cycle and Reproduction 15
Physiology and Adaptability 17
Dispersal and Migration 17
Interspecific Interactions 18
POPULATION SIZES AND TRENDS 19
Sampling Effort and Methods 19
Abundance 20
Fluctuations and Trends 21
Rescue Effect 23
THREATS AND LIMITING FACTORS 24
Predation 24
Human Disturbance 25
Habitat Loss and Degradation 26
Climate Change 26
Livestock Activity 27
Other Threats 27
PROTECTION, STATUS, AND RANKS 28
Legal Protection and Status 28
Non-Legal Status and Ranks 28
Habitat Protection and Ownership 29
ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED 30
Authorities Contacted 30
INFORMATION SOURCES 31
BIOGRAPHICAL SUMMARY OF REPORT WRITER 38
COLLECTIONS EXAMINED 39

List of Figures

Figure 1. Line drawing of breeding Piping Plover (*Charadrius melodus*), © Judie Shore with permission. 5

Figure 2. Distribution map for Piping Plover breeding and wintering ranges (modified from Ridgely *et al.* 2007 by P. Blancher 2011). 8

Figure 3. Adult distribution of Piping Plover interior subspecies (*Charadrius melodus circumcinctus*) in Canada, from the 2011 International Piping Plover Census (map created by A. Filion). 9

Figure 4. Adult distribution of Piping Plover eastern subspecies (*Charadrius melodus melodus*) in Canada, from 2011 International Piping Plover Census and 2012 annual survey data (map created by A. Filion). 10

Figure 5. Piping Plover abundance in Canada 1991–2011, from the International Piping Plover Census (data from Elliott-Smith *et al.* 2009; Goossen and Amirault-Langlais 2010; Porteous pers. comm. 2011; Prescott pers. comm. 2011; Ranalli pers. comm. 2011; Robinson pers. comm. 2011; CWS unpublished data). 21

List of Tables

Table 1. Apparent survival rates and trends calculated for Piping Plovers from data from seven North American studies (Roche *et al.* 2010b). All trends except for Big Quill Lake were significant (95% confidence intervals did not overlap zero). 16

Table 2. International Piping Plover Census results (number of adults) for Canada by subspecies and province, 1991–2011 (data from Elliott-Smith *et al.* 2009; Goossen and Amirault-Langlais 2010; Porteous pers. comm. 2011; Prescott pers. comm. 2011; Ranalli pers. comm. 2011; Robinson pers. comm. 2011; CWS unpublished data). 20

Table 3. Annual survey results (year-end number of adults) for the eastern subspecies of Piping Plover, 1991–2013 (from Rock pers. comm. 2012, Boyne pers. comm. 2013, McKnight pers. comm. 2013). Notes: surveys were not complete from 1992 through 1995; underlined counts indicate incomplete surveys; year-end value for Quebec in 2011 was estimated by using the average ratio of international census counts to annual survey counts from the previous four censuses (Rock pers. comm. 2012). 21

Table 4. Survey results for Piping Plovers in Alberta, 1986–2013 (Prescott *et al.* 2010; Prescott pers. comm. 2011, 2013). 22

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

English name: Piping Plover

French name: Pluvier siffleur

Scientific name: *Charadrius melodus* Ord, 1824

Classification:

Order	Family	Genus	Species
Charadriiformes	Charadriidae	*Charadrius*	*Charadrius melodus*

Two subspecies of Piping Plover are recognized, based on geographic distribution, presence of complete or incomplete neck bands, and differences in mitochondrial DNA (Elliott-Smith and Haig 2004). The interior subspecies, *Charadrius melodus circumcinctus*, breeds inland, in the prairie provinces, Great Plains region of the US, and Great Lakes region of both Canada and the US, while the eastern subspecies, *C. melodus melodus*, breeds along the Atlantic coast of Canada and the US. Although there was some dispute over the designation of the two subspecies in the past (Wilcox 1959, Haig and Oring 1988), more recent genetic studies have confirmed significant differences between the two (Miller *et al.* 2010).

Morphological Description

Piping Plovers are small shorebirds, 17–18 cm in length and weighing 43–63 g (Elliott-Smith and Haig 2004), with backs the colour of dry sand, white underparts, short stout bills, and orange legs. In breeding plumage, a single black band runs across the breast (more complete in interior subspecies than in eastern; Elliott-Smith and Haig 2004) and another black band runs across the forehead between the eyes (see Figure 1); during the breeding season the bills become orange with a black tip. Interior males often have a black "moustache" that runs across the top of the base of the bill between the sand-coloured plumage of the upper cheek (Haig 1992).

Figure 1. Line drawing of breeding Piping Plover (*Charadrius melodus*), © Judie Shore with permission.

During migration, and in some cases on the breeding grounds, Piping Plovers may be confused with Semipalmated Plovers (*C. semipalmatus*), which have a much darker back and paler legs. Occasionally Piping Plovers are confused with the larger Killdeer (*C. vociferus*), which has two breast bands as an adult but only one as a juvenile, or with Snowy Plovers (*C. alexandrinus*), which have a slighter bill and dark legs.

Population Spatial Structure and Variability

Recently, Miller *et al.* (2010) undertook a comprehensive study of subspecies status and population genetic structure in Piping Plovers. Samples were taken from 245 individuals from 23 US states and eight Canadian provinces and were used to analyse mitochondrial DNA sequences (n=245) and eight nuclear microsatellite loci (n=229). The results provide strong support for the division of the species into two subspecies (Φ_{ST} = 0.473 and F_{ST} = 0.104 for mitochondrial and microsatellite data, respectively, $P < 0.0001$), meeting the subspecies definition of Funk *et al.* 2007 (cited in Miller *et al.* 2010). The data were also analysed using five regional groups (prairie Canada, US Great Plains, Great Lakes, Atlantic Canada and Atlantic US), confirming the classification of the Great Lakes birds as part of the interior subspecies (Φ_{ST} = 0.426 and F_{ST} = 0.098, for mitochondrial and microsatellite data, respectively; $P < 0.0001$). Population genetic analyses showed evidence of previous genetic bottlenecks for the interior subspecies, but not for the eastern subspecies. There was also evidence of stronger genetic structure among eastern birds, which possibly reflects greater site fidelity for the eastern subspecies than the interior subspecies.

There is some evidence that the eastern subspecies may consist of two populations: a southern Nova Scotia (sNS) population and a Gulf of St. Lawrence population (hereafter referred to as the Gulf population), encompassing the rest of the Canadian Atlantic range of the species. This is based on the results of a banding study that took place in Atlantic Canada from 1998 to 2003 (Amirault *et al.* 2005). During this study, 888 adults and chicks were banded, and 247 were recaptured. Of the 247 recaptures, 63 were from sNS (31 adults and 32 juveniles). All of the birds originally banded in sNS were recaptured only in sNS and no birds banded elsewhere were recaptured in sNS (CWS unpublished data, McKnight pers. comm. 2011). There were 22 incidences of individuals moving between breeding sites within the Gulf population over the course of the same study, and one instance of a bird from Prince Edward Island moving on to breed in the US in following years (CWS unpublished data, Calvert *et al.* 2006, Rioux *et al.* 2011).

Despite this pattern, the apparent isolation of the sNS population has only been documented over a relatively short period of time, and does not necessarily indicate reproductive isolation. Dispersal distances between sNS and the Gulf population are short, and Piping Plovers are known to exhibit high site fidelity (Cohen and Gratto-Trevor 2011), so it would not be surprising to recapture birds in the same general areas as where they were initially captured. There has also been no genetic work comparing birds in the two regions that could be used to support the separation of these two groups at this time.

Designatable Units

This report covers two designatable units of Piping Plover breeding in Canada: the interior subspecies *Charadrius melodus circumcinctus* and the eastern subspecies *C. m. melodus*.

Special Significance

There have been large-scale public relations campaigns to gain support for Piping Plover management in specific parts of the species' range such as the Magdalen Islands in Quebec and the Acadian Peninsula in New Brunswick (Boyne in press), and in Alberta (Prescott *et al.* 2010). Educational outreach and informational signage are used throughout the range, resulting in a great deal of public concern for the Piping Plover. However, the direct competition between humans and Piping Plovers for prime beach areas has led to conflict (Gratto-Trevor and Abbott 2011).

DISTRIBUTION

Global Range

Piping Plovers are endemic to North America and over a third of the global population breeds in Canada. Breeding populations are found in the Canadian prairies, Ontario (Lake of the Woods and Great Lakes) and on the Atlantic coast. Aboriginal Traditional Knowledge indicates that they may also have been inland in the Bras d'Or Lakes area of Cape Breton, Nova Scotia. In the United States, they are found on the Great Plains, Great Lakes, and the Atlantic coast. There is also a small breeding population on the French islands of Saint Pierre and Miquelon, in the Gulf of St. Lawrence. Breeding range contraction has taken place in the US, particularly along the Great Lakes. Piping Plovers winter along the southern Atlantic coast of the US, along the coast of the Gulf of Mexico in the US and Mexico, and south to Cuba, the Bahamas, and the Caribbean (see Figure 2). Generally, individuals of the interior subspecies winter along the Gulf of Mexico, while eastern individuals winter along the southern Atlantic coast and the Caribbean, especially the Bahamas (Gratto-Trevor *et al.* 2012, Gratto-Trevor unpublished data).

Figure 2. Distribution map for Piping Plover breeding and wintering ranges (modified from Ridgely *et al.* 2007 by P. Blancher 2011).

Canadian Range

Piping Plovers nest in small groups widely distributed among all Canadian provinces except British Columbia (see Figures 3, 4). Based on the data used for the NatureServe map (Figure 2; Ridgley *et al.* 2007; Blancher pers. comm. 2011), the Canadian breeding range is just over half of the global breeding range of 1 242 894 km^2.

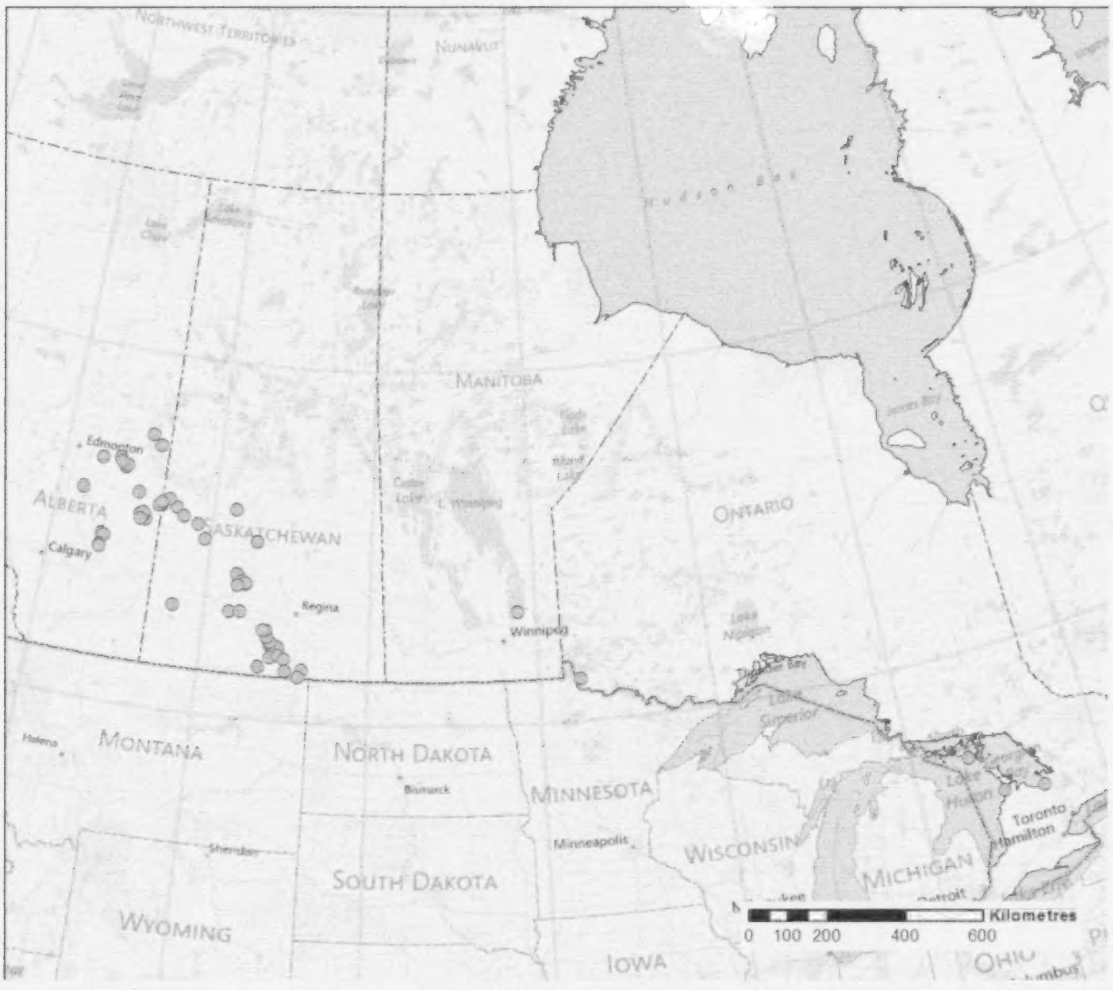

Figure 3. Adult distribution of Piping Plover interior subspecies (*Charadrius melodus circumcinctus*) in Canada, from the 2011 International Piping Plover Census (map created by A. Filion).

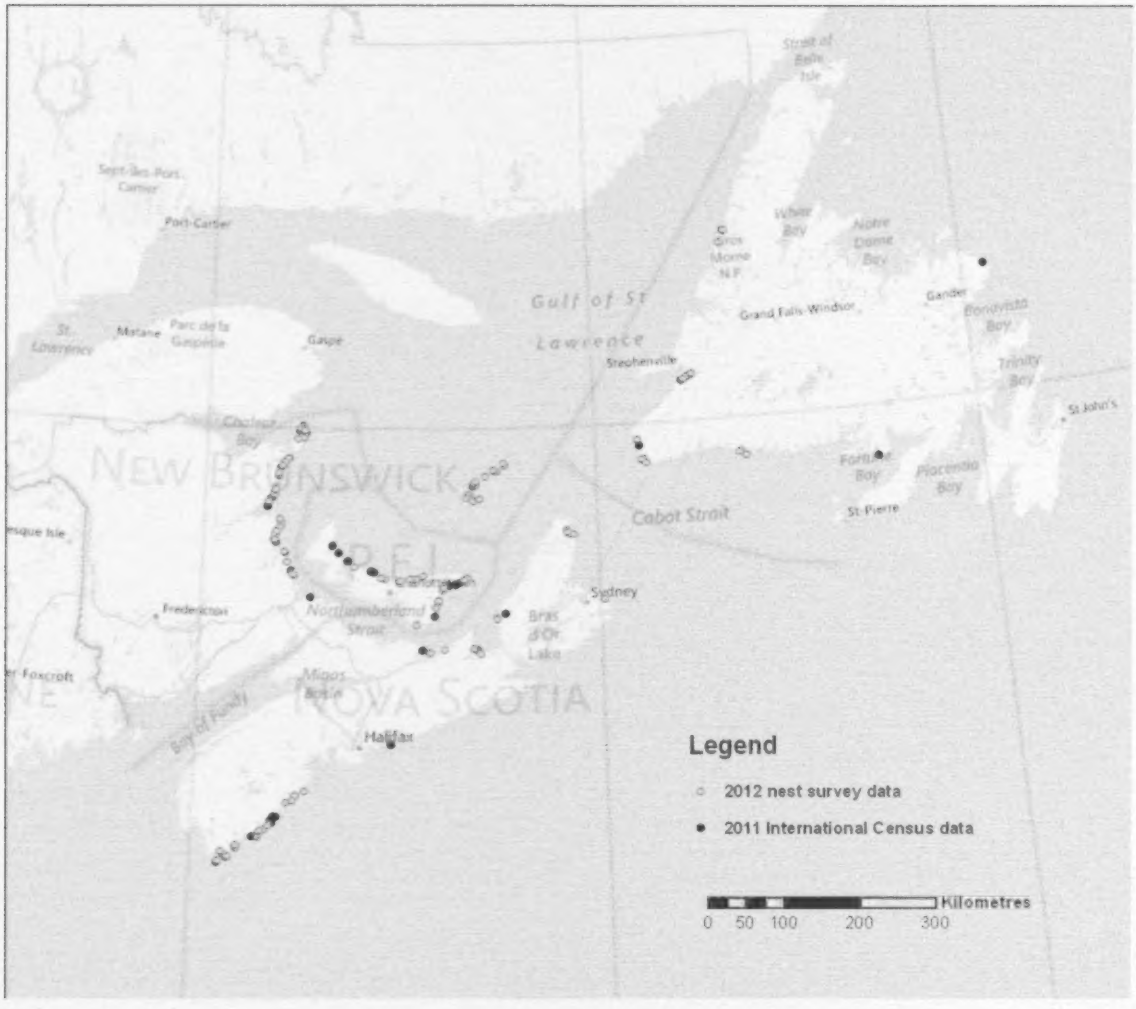

Figure 4. Adult distribution of Piping Plover eastern subspecies (*Charadrius melodus melodus*) in Canada, from 2011 International Piping Plover Census and 2012 annual survey data (map created by A. Filion).

There has been significant contraction in the breeding range of Piping Plovers in Canada. When the original status report (Bell 1978) was prepared, Piping Plovers no longer nested on Sable Island, NS, on islands in the Bay of Fundy, or along Chaleur Bay in Quebec, and their breeding range on the Canadian Great Lakes was restricted to Long Point on Lake Erie. By 2001, Piping Plovers had been extirpated as a breeding species from the North Shore of the Gulf of St. Lawrence, the Canadian Great Lakes and northeast Newfoundland (Boyne in press). There were also fewer breeding sites in the Canadian prairies than there were in 1990 (Elliott-Smith and Haig 2004), and populations dropped to extremely low levels in Ontario and Manitoba (Alberta Piping Plover Recovery Team 2010).

Since that time, there have been some localized expansions of the breeding range in Gros Morne National Park in Newfoundland and Labrador, and a breeding pair on the northeast coast (Rock 2011; Herdman pers. comm. 2013). In Ontario, there has been annual breeding at Sauble Beach since 2007, Wasaga Beach Provincial Park since 2008 and a single breeding attempt at Oliphant Beach in 2008 (St. Laurent pers. comm. 2013). There have also been two nesting events confirmed on Manitoulin Island in Lake Huron (2009, 2013; Boucher pers. comm. 2013). The number of nests at Lake of the Woods has, however, decreased since the late 1980s and early 1990s.

The extent of occurrence (EO) for the interior subspecies in Canada is 555 000 km^2, based on a convex polygon. The EO for the eastern subspecies ranges from 217 600 to 298 500 km^2. A range is presented for the eastern subspecies because a pair bred on the northeast coast of Newfoundland in 2013 and, if breeding persists in this area, the EO could be as large as the latter value. The index of area of occupancy (IAO) for the interior subspecies cannot be calculated because the spatial distribution of breeding pairs at each locality covered by the 2011 International Piping Plover Census is unknown. The IAO for the eastern subspecies is 424 km^2. This is based on a 2 km X 2 km grid placed over the breeding sites mapped during the 2011 census and the 2012 annual survey, the most recent available information on the location of nest sites.

Search Effort

The International Piping Plover Census has taken place every five years since 1991 and provides a critical overview of the global abundance of Piping Plovers. By attempting to count every bird in all known or potentially suitable habitat during a specified two-week period, the census provides a snapshot of the entire population at one time. In many regions, such as Saskatchewan, where breeding habitat is widely distributed and not easily or practicably accessible on a yearly basis, this is the only survey information available.

In Atlantic Canada, the census counts have been compared to annual year-end counts (see below). The two methods provide relatively consistent results with the census counts, accounting for an average (± SD) of 89.8 ± 2.1% of adults reported in the annual year-end population counts (range: 87.4 - 92.3%; Rock 2011). This suggests that the census provides a reasonably accurate indication of population size.

The census does, however, have several limitations. Because the population of Piping Plovers is small relative to the species' range and breeding habitat is widely dispersed, a complete count of all individuals is not possible. The census includes all shorelines and wetlands known to have contained plovers in the past, as well as other potentially suitable habitat; however, as suitable habitat is determined based on expert knowledge and not a widespread survey of potential habitat, the census may fail to count plovers that have colonized new or suboptimal habitat patches. This could be significant in years when conditions such as the widespread flooding in the Prairies in 2011 made typical breeding habitat unavailable. Although there has been some effort to correct counts for imperfect detection, modern methods to estimate detection probability

have not been employed on a wide scale so it is difficult to put confidence limits on the counts (Gratto-Trevor and Abbott 2011). Extreme variability in habitat conditions across years has confounded estimation of population trends for prairie populations, especially when the five-year window coincides with extremely high water levels (as in 2011), or drought, both of which can force plovers into alternate breeding habitat not covered by the census (Cohen and Gratto-Trevor 2011, Roche *et al.* 2012).

Despite these limitations, the International Piping Plover Census provides a standardized survey across the range of the species, which allows for meaningful comparisons between different regions and jurisdictions. The search effort involved is enormous. In 2006, for example, 12 400 km of potential habitat across the entire range of the species was searched, including 2470 sites, by more than 1300 observers (Elliott-Smith *et al.* 2009). The breeding census covered almost 8000 km, of which almost 3300 km (close to 750 sites and 400 observers) were in Canada (Elliott-Smith *et al.* 2009).

Annual counts also take place in some Canadian jurisdictions. Surveys have taken place annually in Alberta since 2000 (Prescott *et al.* 2010; Prescott pers. comm. 2011). Annual surveys have also been done consistently across Atlantic Canada and Quebec since 1996 (Rock pers. comm. 2012; see Sampling Effort and Methods section for more details).

HABITAT

Habitat Requirements

Piping Plover breeding habitat can be loosely described as open sandy to gravelled beaches with sparse vegetation (Elliott-Smith and Haig 2004) and mixed substrates, and is found in a wide variety of habitats across Canada and the US. In the Canadian prairies, the interior subspecies favours wide beaches on the shores of alkali lakes and wetlands and can also be found nesting adjacent to reservoirs and freshwater lakes and wetlands. In Ontario, this subspecies is found on sand and pebble beaches on barrier islands, peninsulas or the shores of large lakes (Environment Canada 2013). On the Atlantic Coast, the eastern subspecies most commonly nests on sandy beaches found on barrier islands, oceanfronts, bays and sand bars, preferring early successional habitat that is most often free of dense vegetation (Environment Canada 2012).

Piping Plovers prefer to nest on the widest sections of beach with mixed substrates such as gravel, shells, sticks, and pebbles. Nesting on wider sections allows birds to nest far from the vegetation line and the water, which possibly reduces the risk of predation and flooding, respectively (Boyne in press). Mixed substrates provide camouflage from predators and protection from wind, and the presence of mixed substrates may be an indication that a section of beach is less susceptible to flood or storm tides because tides have not previously removed debris from these areas (Burger 1987). In Atlantic Canada, beaches occupied by nesting plovers on the Gulf of St. Lawrence were wider and had more mixed substrate than those on the Atlantic coast of Nova Scotia, suggesting that the Gulf sites may provide better quality nesting habitat (Boyne and Amirault 1999).

Habitat Trends

Piping Plovers breed and winter in areas where the potential for conflict with humans is high. As such, habitat is lost indirectly through displacement of plovers by humans using beaches for recreation, as well as directly as a result of development in coastal and riparian habitat. Anthropogenic habitat loss is exacerbated by natural processes such as floods, droughts, and erosion that reduce habitat availability and quality. Sites with suitable habitat free of human disturbance are becoming increasingly rare and more fragmented in most areas, as development and recreational use increases. For example, ATV activity in Alberta increased significantly from 2005 to 2010, resulting in substantial habitat damage and nest loss, and efforts to protect plover habitat from motorized traffic have been largely unsuccessful (Prescott *et al.* 2010). Piping Plovers driven from traditional breeding sites often have the option of nesting in unsuitable habitat with no human disturbance or in suitable habitat with human disturbance. Both options could result in low reproductive success and/or low survival. The availability of alternate habitat has also decreased significantly: 40% of wetlands in Saskatchewan have been drained over the past 100 years, and in some areas up to 90% of wetlands no longer provide suitable breeding habitat (Roche *et al.* 2012).

Habitat loss through water level fluctuations is a key issue on the prairies. These fluctuations occur naturally, caused by drought and floods, and artificially through water level stabilization and management for hydropower. While periodic flooding is necessary to preserve successional habitat, high water during the breeding season can force plovers from nesting sites and flood nests. During extreme droughts the distance between nest sites and the water's edge may preclude nesting, and many wetlands may become completely dry. Water level stabilization, often for recreational or agricultural purposes, can result in vegetation encroachment and a long-term decrease in habitat availability. At Lake Diefenbaker, SK, where the reservoir is controlled for hydropower and other uses, water levels can rise quickly during the breeding season, flooding nests and reducing chick-rearing habitat (Espie *et al.* 1996, Roche *et al.* 2012). As a result, productivity can be extremely low. In 1991, Lake Diefenbaker had the largest concentration of Piping Plovers in North America with 14% of the Canadian population breeding along its shores (276 individuals; Haig and Plissner 1993). In 1996, water levels in the reservoir were higher and only 75 Piping Plovers were observed (Plissner

and Haig 2000a). The Water Security Agency of Saskatchewan (formerly the Saskatchewan Watershed Authority) is involved in the South Saskatchewan Piping Plover Conservation Plan, and works to reduce the impacts of management of water levels at Lake Diefenbaker on Piping Plovers (Bidwell pers. comm. 2012).

Although breeding habitat is not limited, suitable habitat in the Great Lakes region continues to decline, because of human recreation, beach management for aesthetic purposes (e.g., raking and removing debris), vegetation encroachment, invasive species (e.g., *Phragmites*), development for recreational and residential uses, and increased populations of predators (St. Laurent pers. comm. 2012).

In eastern Canada, natural habitat change has occurred on traditional Piping Plover nesting beaches, such as St. Catherines River Beach, Kejimkujik National Park, NS (Austin-Smith *et al.* 1994, Boates *et al.* 1994, Wentzell 1997). Marram Grass (*Ammophila breviligulata*), Bayberry (*Myrica pensylvanica*), and even spruce trees (*Picea* spp.) have spread across the beach, making it less suitable for plovers. Historically, St. Catherines River Beach was the most important Piping Plover breeding beach in Nova Scotia. Fifty-four adult Piping Plovers were observed on the beach in 1979, but in 1999 only 10 adults were observed (Boyne in press) and only six adults were recorded in the 2011 census (CWS unpublished data). Anthropogenic effects on habitat are a larger factor than natural habitat change. Habitat in eastern Canada continues to be lost to coastal development and stabilization; disturbance by humans, dogs and vehicles; and increases in numbers of egg and chick predators (see Biology section). These same factors are also significant causes of habitat loss in the US wintering grounds along the Atlantic coast and the Gulf of Mexico.

Habitat loss and degradation are of particular concern in southern Nova Scotia, along the Atlantic coast. Overall, the plovers that breed in this region are more habitat-limited than are those that breed on beaches in the Gulf of St. Lawrence (Abbott pers. comm. 2011), and the beaches are subjected to more extreme wave and weather events (Flemming *et al.* 1992, Boyne and Amirault 1999, Abbott pers. comm. 2011). The causes of this habitat loss are varied: natural changes to beaches over time, consistent flooding by storms and extreme high tides, management for recreational and tourism needs, development by cottagers, degradation by intense vehicle use, and predator pressures (e.g., resident foxes "keyed in" to plovers) that preclude successful breeding (Abbott pers. comm. 2011).

BIOLOGY

Life Cycle and Reproduction

Adult Piping Plovers arrive on the breeding grounds in Canada from mid-April to mid-May, often returning to the same nesting area in consecutive years. The males arrive earlier than females, select beach habitats, and defend their territories against other males (Hull 1981). Nests are made by the males, and are simple depressions or scrapes in the sand, often lined with pebbles, shells or driftwood for camouflage (NatureServe 2012). Piping Plovers are generally monogamous during a single breeding season, although they may change mates if a clutch is lost (Elliott-Smith and Haig 2004).

A clutch usually consists of four eggs (often less in cases of renesting). The adults share incubation, and eggs hatch after about 28 days. Both parents brood and tend the chicks; however, females may abandon the brood before the chicks fledge. Plovers will re-nest if a clutch is lost, up to five times in one season; however, the more clutches produced by a single female, the more likely she is to abandon her brood earlier after hatching (Gautreau 1998, cited in Boyne in press), leaving the chicks more vulnerable to predation and inclement weather.

Chicks are able to fly 18–35 days after hatching, and the average number of young fledged per nesting pair is usually one or two. Fledging success is highly variable and depends on weather, disturbance, water levels, and predation. In the northern Great Plains, on average less than one chick per breeding pair is fledged (Goossen *et al.* 2002). Using mark-resight data for Piping Plovers breeding in Saskatchewan from 2002 to 2009, Cohen and Gratto-Trevor (2011) calculated mean fledging rates ranging from 0.87 to 0.96 young per pair. From 2007 (when breeding plovers returned to the Great Lakes region) through 2012, on average 1.6 fledglings have been produced per breeding pair on the Great Lakes (range 0.33 to 3.0; St. Laurent pers. comm. 2012). From 1996 through 2012, average fledging rates were 1.58 ± 0.27 in the Gulf region and 1.59 ± 0.43 in southern Nova Scotia for the eastern subspecies.

Fledglings often remain with their parents but leave the natal territory to stage before migration. It is unknown how many chicks return after their first winter, but some are known to remain on the wintering grounds throughout their first summer, whereas others have been observed breeding in their first spring. In a study of 991 banded chicks in Saskatchewan from 2000 to 2006, Gratto-Trevor *et al.* (2010) found that 68% of females and 41% of males bred as yearlings, with most others (29% of females and 50% of males) first breeding in their second year. All plovers are assumed to breed by their fourth year (Calvert *et al.* 2006), but not all plovers find mates every year (Haig 1992, Calvert *et al.* 2006).

In 2001, Boyne (in press) calculated the average age of the breeding population as 4–5 years based on survival rates from Melvin and Gibbs (1994). Banding records from a 20-year banding study found that at least 12 of 298 birds lived to be 8–11 years of age; however, only 28% percent of males and 13% of females lived to be older than five years of age (Wilcox 1959). More recent evidence from an extensive five-year banding study in eastern Canada (1998–2003; see Designatable Units section for more details) suggests that the majority of plovers in eastern Canada live to only four years of age, as only 7% of recaptured juveniles were more than four years of age at the time of their last capture (CWS unpublished data). Roche *et al.* (2010a) recorded a median age of 3.0 years for nesting plovers in the Great Plains region. Based on this recent work, the generation time for Piping Plovers is likely between 3 and 4 years of age.

Roche *et al.* (2010b) undertook a range-wide study of the apparent survival rates and trends for Piping Plovers, using long-term (1998–2008) mark-recapture data collected from seven separate studies located throughout North America (Table 1). The banding data came from four sites in the Prairies/Great Plains (Big Quill Lake, SK; Prairie Coteau, SK, Lake Diefenbaker, SK; Missouri River, SD), one site from the Great Lakes (Great Lakes, MI), and two from the Atlantic Coast (Atlantic Canada; Long Island, NY). Apparent survival rates were generally highest among the Prairie/Great Plains breeding populations; all seven sites had declining trends in annual survival (Table 1). True survival rates (not confounded with permanent emigration) for Piping Plovers in Saskatchewan from 2002 to 2009 were calculated as 0.80 for adults and 0.57 for subadults (Cohen and Gratto-Trevor 2011), and also declined over time. Calvert *et al.* (2006) calculated apparent survival rates of 0.73 for adults in eastern Canada, and 0.53 and 0.34 for juveniles in southern Nova Scotia and the Gulf of St. Lawrence, respectively.

Table 1. Apparent survival rates and trends calculated for Piping Plovers from data from seven North American studies (Roche *et al.* 2010b). All trends except for Big Quill Lake were significant (95% confidence intervals did not overlap zero).

Population	Apparent Annual Survival	Trend in Survival Rate
Big Quill Lake, SK	0.81	-0.15
Prairie Coteau, SK	0.69	-0.26
Lake Diefenbaker, SK	0.76	-0.19
Missouri River, SD	0.80	-0.19
Great Lakes, MI	0.71	-0.08
Atlantic Canada	0.66	-0.21
Long Island, NY	0.58	-0.49

Physiology and Adaptability

To help with temperature regulation, young chicks are brooded every 5 to 10 minutes for the first few days after they hatch (Haig 1992), with brooding becoming less frequent until after about 21 days, when brooding rarely occurs (Cairns 1977). Brooding occurs less often when birds are disturbed by humans, which increases the chicks' vulnerability to predators and inclement weather, resulting in lower chick survival on beaches with human disturbance (Flemming *et al.* 1988).

In the past, Piping Plovers could relocate to new breeding sites when traditional sites became inhospitable; however, as the number of suitable sites that are free from disturbance decreases so do the options for changing sites. There is evidence that plovers are able to adapt to human disturbance to some degree, as plovers at disturbed sites are more reluctant to flush from their nests than those at undisturbed sites.

When threatened by predators, adult plovers lure predators away from their young with a broken wing display (Haig 1992). The chicks crouch in the sand where they are well camouflaged from natural predators, but are vulnerable to being stepped on by people or run over by vehicles.

Dispersal and Migration

Natal philopatry varies widely, but tends to be low, although birds do more often return to the same general area as their natal site (Elliott-Smith and Haig 2004). Breeding site fidelity is stronger, except perhaps where breeding habitat is ephemeral (Knetter *et al.* 2002, cited in Elliott-Smith and Haig 2004), and birds tend to use nearby sites if the previous year's site is not available. Less information is available on fidelity to wintering sites, but indications are that it is also quite high, with little movement taking place within the wintering site itself (Elliott-Smith and Haig 2004, Gratto-Trevor *et al.* 2012). The strong breeding and wintering site fidelity exhibited by Piping Plovers serves to maintain separation between different populations, and reduces the likelihood of rescue from neighbouring populations when the local population has been extirpated.

There has been only one report to date of an individual marked as a hatchling or breeding adult in the range of one subspecies and then identified as breeding in the range of the other (Hillman *et al.* 2012). On the Great Plains, estimates of breeding site fidelity range between 42% and 71% for adults and less than 14% for juveniles (Prescott *et al.* 2010). Approximately 90% of birds banded in Alberta were recorded in Alberta in subsequent years (Prescott *et al.* 2010). The remaining 10% of banded individuals were reported from lakes in Saskatchewan, suggesting there is some movement between breeding areas in the two provinces. There are also a few records of movements of adults and young between the US Great Plains and the Canadian prairies (Roche *et al.* 2012; St. Laurent pers. comm. 2012).

In Atlantic Canada, only 22 instances of inter-jurisdictional dispersal, by 20 individuals, were recorded over a five-year banding study (see Designatable Units section for more details). Of these, 15 were of first-time breeders to another Atlantic province and six were of breeding adults to a breeding site in another Atlantic province. The other two cases include a single male from Prince Edward Island that moved on to breed in the US in following years (New York, and then Massachusetts), which may not represent significant gene flow or recovery potential between the Canadian and US Atlantic populations (CWS unpublished data).

Northward migration begins in late February, with the peak number of departures occurring in March. Few birds are left on the wintering grounds by mid-April. Birds are first seen in their southernmost breeding sites in mid-March, with most Canadian breeders arriving in early May. In some years birds may leave their breeding sites in late June (Haig 1992); however, southward migration generally extends from late July until September (USFWS 1996). Females tend to leave first, followed by unpaired males, then males with fledglings, and finally unaccompanied young (Eubanks pers. comm. cited in Haig 1992). There are few data about the duration of migration.

Individuals of the interior subspecies appear to migrate nonstop to and from their wintering grounds, as they are very rarely seen at seemingly appropriate inland stopover places (Haig 1992, Elliott-Smith and Haig 2004, Prescott *et al.* 2010). Small groups of the eastern subspecies are frequently observed on nesting and non-nesting beaches along the Atlantic coast during spring and fall migration, suggesting that they migrate in stages (Boyne in press).

Interspecific Interactions

Piping Plovers feed primarily on terrestrial, marine, and freshwater invertebrates along the shoreline. There is no evidence that plovers have preferred prey types, but studies show that broods with access to pondshore mudflat habitat (Goldin and Regosin 1998, cited in Boyne in press) or bay beach or island interior habitat (Loegering and Fraser 1995, cited in Boyne in press) were more successful than broods limited to oceanfront habitat. These habitats may have higher densities of certain prey types such as terrestrial arthropods (Loegering and Fraser 1995, cited in Boyne in press). Given that Piping Plovers are found at low densities and are generalist feeders, they likely have little impact on prey species.

Piping Plovers have been observed nesting within colonies of Common Terns (*Sterna hirundo*) and Least Terns (*S. antillarum*), where they benefit from the terns' mobbing defence against avian predators (NatureServe 2012). They have been recorded as having a similar commensal relationship with American Avocets (*Recurvirostra americana*). Sixty-two percent of plover nests in areas used by avocets succeeded compared to 29% in areas without avocets (Prindiville Gaines and Ryan 1988).

Predation (of eggs, chicks and adults) is an important factor limiting Piping Plover breeding success. Common predators include Red Foxes (*Vulpes vulpes*), Mink (*Mustela vison*), Raccoons (*Procyon lotor*), Striped Skunks (*Mephitus mephitus*), Coyotes (*Canis latrans*), Merlins (*Falco columbarius*), gulls (*Larus* spp.), Black-billed Magpies (*Pica hudsonia*), and other corvids (*Corvus* spp.). A number of these predators benefit from association with humans (Prugh *et al.* 2009, Gratto-Trevor and Abbott 2011), which can result in higher populations in areas frequented by people, and many are attracted to garbage left behind at beaches. Domestic and feral pets also prey on plover chicks and adults, and destroy nests.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

The International Piping Plover Census, which provides the most complete and standardized population estimates for Piping Plovers across North America has now taken place five times (1991, 1996, 2001, 2006, 2011; see Search Effort section for more details on methods and limitations). Surveys on the breeding grounds generally take place within the first two weeks of June, and cover all potential nesting sites in North America (Canada, the US, and the French islands of Saint Pierre and Miquelon). Surveys of wintering grounds take place in mid-January, and currently cover the Gulf of Mexico and Atlantic coasts of the southern US and Mexico, Cuba, the Bahamas, and several Caribbean islands.

For the interior subspecies, the only estimates of population size and trends for the entire subspecies are from the international census. Annual surveys have been conducted consistently in Alberta since 2001 (Prescott *et al.* 2010), but only the international census provides counts across the entire range of the subspecies.

For the eastern subspecies, annual surveys have been conducted since 1991, and consistently since 1996, and provide the best estimate of population size and trend information for this subspecies. Piping Plovers nest in fairly linear and discrete habitat along eastern beaches, minimizing the probability that breeding birds are missed (Calvert *et al.* 2006). Beaches are surveyed at the beginning of the breeding season, and then those on which pairs or single birds were located are visited regularly throughout the breeding season. Year-end counts are the total number of adults observed at the end of the breeding season.

Abundance

The most recent population numbers from the 2011 International Piping Plover Census indicate a Canadian population of approximately 1439 adults of which 1033 individuals are of the interior subspecies and 406 are of the eastern subspecies (Table 2). The count for the interior subspecies might be an underestimate because some birds may have been displaced from their usual breeding beaches and not counted because of unusually high levels of flooding in 2011. This hypothesis has not, however, been tested and there has been consistent flooding since the last census in 2006 so some decrease in numbers is expected.

Table 2. International Piping Plover Census results (number of adults) for Canada by subspecies and province, 1991–2011 (data from Elliott-Smith *et al.* 2009; Goossen and Amirault-Langlais 2010; Porteous pers. comm. 2011; Prescott pers. comm. 2011; Ranalli pers. comm. 2011; Robinson pers. comm. 2011; CWS unpublished data).

	1991	1996	2001	2006	2011
interior subspecies	1437	1688	973	1704	1033
Alberta	180	276	150	274	244
Saskatchewan	1172	1348	805	1420	771
Manitoba	80	60	16	8	2
Ontario	5	4	2	2	16
eastern subspecies	494	405	466	457	406
Quebec	61	87	55	63	66
New Brunswick	203	146	167	166	130
Nova Scotia	113	79	93	87	92
Newfoundland and Labrador	7*	27	39	48	51
Prince Edward Island	110	66	112	93	67
Total for Canada	1931	2093	1439	2161	1439*

In 2013, the annual survey total for the eastern subspecies of Piping Plovers was 389 (Table 3).

* Effort changed significantly between 1991 and the following years in NL (Herdman pers. comm. 2013).

Table 3. Annual survey results (year-end number of adults) for the eastern subspecies of Piping Plover, 1991–2013 (from Rock pers. comm. 2012, Boyne pers. comm. 2013, McKnight pers. comm. 2013). Notes: surveys were not complete from 1992 through 1995; underlined counts indicate incomplete surveys; year-end value for Quebec in 2011 was estimated by using the average ratio of international census counts to annual survey counts from the previous four censuses (Rock pers. comm. 2012).

	1991	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
New Brunswick	218	148	135	162	187	177	174	212	233	186	153	183	172	179	150	161	131	111	108
Newfoundland and Labrador	11	32	38	30	34	38	49	47	43	41	50	55	58	57	65	55	50	51	51
Nova Scotia	125	87	90	76	96	96	109	104	107	84	74	84	92	89	104	101	101	99	107
Prince Edward Island	110	73	66	101	89	91	121	120	92	94	85	114	120	98	94	82	74	60	63
Quebec	76	124	90	72	88	72	70	74	74	74	82	82	90	88	96	70	86	58	60
Total Eastern Canada	540	464	419	441	494	474	523	557	549	479	444	518	532	511	509	469	442	379	389

Fluctuations and Trends

On the longer term (1991–2011), the interior subspecies has shown a decline of 22.9%, based on a linear regression on the count data from the International Piping Plover Census (Table 2). Over the most recent 10-year period (2001–2011), the interior subspecies has shown a decline of 12.2%. This estimate is based on applying the rate of decline for the entire time series to the last 10-year period. This is the most robust approach given the fluctuations in counts for the interior subspecies over time (Figure 5) and the limited number of data points available (i.e. three) over the last 10-year period.

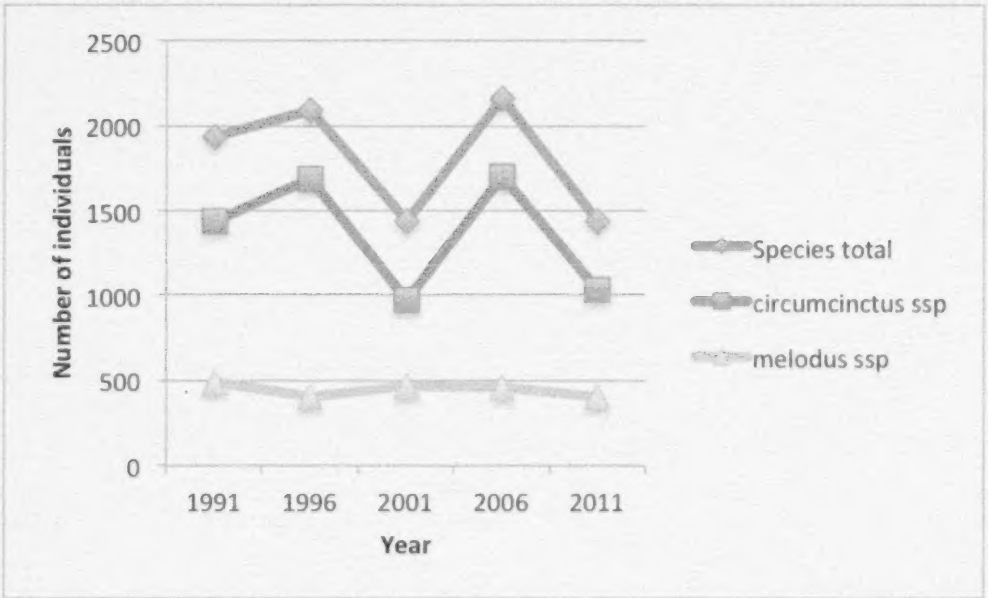

Figure 5. Piping Plover abundance in Canada 1991–2011, from the International Piping Plover Census (data from Elliott-Smith *et al.* 2009; Goossen and Amirault-Langlais 2010; Porteous pers. comm. 2011; Prescott pers. comm. 2011; Ranalli pers. comm. 2011; Robinson pers. comm. 2011; CWS unpublished data).

Using linear regression, annual survey results for the eastern subspecies show a non-significant long-term (1991–2013) decline of 13% (P = 0.15) and a significant short-term (2003–2013) decline of 23.3% (P = 0.014) over the last 10 years or approximately three generations.

Annual survey data are not available for the interior population as a whole; however, surveys have been conducted annually in Alberta (Table 4). The results of linear regression analyses for the Alberta population show a non-significant increase of 17.8% (P = 0.53) over the last 10 years or approximately three generations and a non-significant increase of 46.8% (P = 0.12) since consistent monitoring began in 2001.

Table 4. Survey results for Piping Plovers in Alberta, 1986–2013 (Prescott *et al.* 2010; Prescott pers. comm. 2011, 2013).

Year	Total Adults
1986	288
1991	180
1996	276
2001	150
2002	141
2003	152
2004	134
2005	206
2006	274
2007	273
2008	295
2009	215
2010	233
2011	244
2012	175
2013	178

The large fluctuations in population estimates for the interior subspecies from the international census and the lack of annual data for most of this population make it difficult to get clear picture of the population trend for this subspecies. Because of this, and to explore the implications of the decline in adult survivorship described in Cohen and Gratto-Trevor (2011) on population trends, Calvert and Gratto-Trevor (pers. comm. 2012) recently applied the projection model described in Calvert *et al.* (2006) to this population. They calculated vital rates using data from a number of studies (Gratto-Trevor unpublished data, Gratto-Trevor *et al.* 2010, Cohen and Gratto-Trevor 2011) to build a preliminary deterministic model that would estimate a projected growth rate. They modelled two scenarios: an "average" scenario based on the mean productivity values observed over the last 11 years for breeding birds in Saskatchewan, where most of the interior subspecies occurs, and a "worst-case" scenario using the lowest estimate of productivity (from Gratto-Trevor unpublished data). The "average" scenario resulted in a projected growth rate of 0.997, which results in a population loss of about 3% over 10 years. The "worst-case" scenario resulted in a projected growth rate of 0.860, which would result in a loss of about 80% over 10 years.

Rescue Effect

The distribution of the interior subspecies in Canada is contiguous with that of the subspecies in the US, and the habitat is similar, so the potential for rescue exists. Piping Plovers are, however, listed as Endangered or Threatened on their US breeding grounds, which reduces the potential for rescue. They also exhibit strong site fidelity both on their breeding and wintering grounds, and surprisingly little overlap has been observed between the Canadian prairie population and that of the US Great Plains (see Dispersal and Migration; Prescott *et al.* 2010, Gratto-Trevor *et al.* 2012). Given this, it is unlikely that inter-jurisdictional movement would be sufficient to rescue the interior subpopulation, despite recent increases in the Great Plains population (Gratto-Trevor and Abbott 2011). There has, however, been some exchange of individuals between Canada and the US within the Great Lakes region, and the return of a small number of plovers to the Canadian breeding population there is a result of successful recovery work in the US (St. Laurent pers. comm. 2012), where numbers have been increasing as a result of intensive management (Gratto-Trevor and Abbott 2011).

Very little exchange between Canada and the US has been observed for the eastern subspecies. Only one banded Canadian bird appeared to move to the US from Atlantic Canada from 2003 to 2008, and no US birds were reported in Canada (CWS unpublished data), making rescue unlikely despite significant increases in the US Atlantic population over the last 30 years (Gratto-Trevor and Abbott 2011).

THREATS AND LIMITING FACTORS

Throughout much of its range, the Piping Plover inhabits areas that are under intense human pressure, in both the breeding and wintering grounds, and it exists at low densities in fragmented habitats within its range. The species' concentration in dispersed patches of habitat leaves it more vulnerable to a variety of threats. Despite extensive research, conservation and recovery attention for over 50 years, the species has not shown signs of recovery. Its survival is now considered to be management-dependent in most if not all of its range (Environment Canada 2012).

Predation

Predation is considered to be a primary threat to breeding Piping Plovers in all regions (Gratto-Trevor and Abbott 2011). In the Great Plains and Canadian prairies, it is believed that predation has increased as a result of human activities on the landscape, and there has been a steady increase in populations of Black-billed Magpies, California Gulls (*Larus californicus*), Ring-billed Gulls (*L. delawarensis*) and American Crows (*Corvus brachyrhynchos*), all of which are considered to be substantial predators of Piping Plover eggs and young (Westworth *et al.* 2004). Natural levels of predation have been augmented by human-induced changes that have increased the distribution and abundance of predators that adapt well to human presence, as well as of domestic and feral animals. National Parks, while still important for the species as a whole (see Legal Protection and Status section), do not necessarily see greater productivity than do areas outside the parks, as predators are also protected within the parks and some benefit from the presence of human visitors (Prugh *et al.* 2009, Gratto-Trevor and Abbott 2011).

Significant increases in productivity have been achieved on the prairies through the use of predator exclosures (e.g., Richardson 1999, Prescott *et al.* 2010). Exclosures have been used extensively since the mid-1990s (>90% of nests found since 2002; Prescott *et al.* 2010) in Alberta, where the probability of success of an unprotected nest appears to be the lowest in North America (Alberta Piping Plover Recovery Team 2010). In other jurisdictions, however, the benefits of exclosures have been outweighed by increased adult mortality, and there is evidence that abandonment is higher at exclosed nests, resulting in minimal use of exclosures in these regions (Murphy *et al.* 2003, Barber *et al.* 2010, Calvert and Taylor 2011, Gratto-Trevor and Abbott 2011). Predator control, in the form of predator removal or destruction of nests and potential habitat of avian predators, has been used to some extent in prairie Canada and the US Great Plains, Great Lakes and Atlantic regions (Gratto-Trevor and Abbott 2011, St. Laurent pers. comm. 2012).

Predation does not appear to be a significant threat to adult Piping Plovers on their coastal migration and wintering grounds; but the extent of predation remains largely unknown (USFWS 2012a). Human activities affect the types, numbers, and activity patterns of some predators in the migration and wintering grounds, and avian and mammalian predators are common throughout the range. Piping Plovers, however, may benefit from predator management programs already in place in, for example, the Florida Keys National Wildlife Refuge and beach ecosystems in North Carolina, South Carolina, Florida and Texas (USFWS 2012a).

Human Disturbance

Human disturbance is also a major threat to Piping Plovers across their range. Conflicts arise because Piping Plovers nest on wide, sandy beaches, which can experience heavy recreational use by large numbers of people during the plover breeding season, and also on the migration and wintering grounds. Human disturbance reduces Piping Plover productivity in several ways, both directly through the destruction of eggs and nests and indirectly through effects on behaviour. Humans and their domestic pets can flush birds from their nests and increase vigilance behaviour by the plovers, reducing time spent feeding, incubating eggs or brooding chicks. Birds that are flushed from their nests or cover are also more vulnerable to other threats such as inclement weather, predation (of themselves or their eggs), and off-road vehicles. Examples from the Great Lakes of disruptive activities include the use of fireworks on nesting beaches, and kite flying (or kite boarding) that can mimic avian predators (Environment Canada 2013).

Efforts to reduce the impact of human disturbance on Piping Plover populations include signage on beaches and in beach parking lots, seasonal closures of beaches, symbolic fencing (markers that draw attention to nesting sites without blocking access), educational outreach at breeding sites, guardian programs (significant long-term contribution throughout Atlantic Canada and in the Ontario Great Lakes region), and laws forbidding the use of motor vehicles on beaches. The use of all-terrain vehicles continues to be a significant issue on both inland and coastal beaches, and enforcement is limited in most areas (Prescott *et al.* 2010, Environment Canada 2012). Besides the direct destruction of nests and chicks, vehicles also affect Piping Plovers indirectly by compacting the beach (making feeding more difficult for the plovers) and leaving tire tracks that are deep enough to trap chicks.

Habitat Loss and Degradation

Habitat loss is an ongoing threat to Piping Plovers. Habitat loss linked to human activities is exacerbated by the fact that Piping Plovers nest in unstable environments. On the prairies, the natural cycle of high and low water causes fluctuations in habitat availability both temporally and spatially; freshwater dune habitat used on the Great Lakes and at Lake of the Woods is dynamic, and the sandbars and oceanfront beaches where plovers nest in Atlantic Canada are constantly being eroded and created. On the Atlantic coast, mechanized beach cleaning, dune restoration, and recreational development alter habitat making it unsuitable for nesting, and similar threats affect Great Lakes beaches, while agriculture, and oil and gas development degrade or eliminate habitat on the prairies. The use of off-road vehicles on beaches in Newfoundland has led to the loss of some dune habitat and damage that leaves beaches vulnerable to significant change (Herdman pers. comm. 2013). Nesting habitat in the prairies is also lost as a result of the stabilization of lake levels, which allows vegetation to encroach onto beaches making them unsuitable for nesting, and to flooding from reservoirs such as Lake Diefenbaker (see Habitat Trends section for more details). Water levels appear to have played a key role in the population declines observed in Alberta and Saskatchewan in 2011. An extremely wet spring and summer (record high rainfall in many parts of Alberta) resulted in flooding of many key nesting beaches and limited the availability of suitable nesting habitat on several others.

Continuing loss and degradation of habitat is likely the key threat to Piping Plovers in their coastal migration and wintering range (USFWS 2012a). Sand placement projects, inlet stabilization, sand mining, groins, seawalls and revetments, dredging of canal subdivisions, invasive vegetation and wrack removal all contribute to this cumulative loss, and increase competitive pressures between Piping Plovers and the many other shorebird species found within their ranges. Shoreline stabilization impedes the natural processes by which coastal habitats respond to storms, while accelerating sea level rise and recreational use of beaches further reduces their suitability as habitat (USFWS 2012a).

Climate Change

Climate change is expected to result in drier conditions on the prairies, which could lead to a reduction in the amount of suitable habitat available to plovers; an increase in extreme weather events (including both inland and coastal storms, as well as frequency of strong hurricanes); and rising sea levels. The narrow beaches used by Piping Plovers along the southern (Atlantic) coast of Nova Scotia could be affected by rising sea levels associated with climate change (Abbott pers. comm. 2012). Daigle *et al.* (2006) identified the Gulf of St. Lawrence as being particularly sensitive to sea-level rise as well, and concluded that an increased frequency of summer surges would have a negative effect on Piping Plovers breeding in that region.

Large storm surges are also a threat on the wintering grounds. Grinsted *et al.* (2012) used data from tide gauges along the southeastern United States to construct a record (independent of improvements in detection ability) of cyclone activity dating back to 1923. They found that 1) in general, more cyclones (of all sizes) occurred in warm years than in cold years; 2) the relative increase in frequency in warm years is largest for the strongest cyclones; and 3) there is a statistically significant increasing trend in the frequency of large surge events since 1923. Based on these findings, more and stronger cyclones would be predicted to occur as global warming continues.

Livestock Activity

Cattle and horses with access to plover habitat can alter the characteristics of the habitat, disrupt normal breeding behaviour, trample eggs and chicks, and leave hoof prints deep enough to trap chicks (Alberta Piping Plover Recovery Team 2010). Also, the construction of dugouts near shorelines can foul nesting beaches, change basin hydrology, and accelerate encroachment of vegetation (Alberta Piping Plover Recovery Team 2010). The impacts of livestock on Piping Plover populations, however, can be effectively reduced through inexpensive means, and virtually all key habitat in Alberta is now protected from cattle disturbance (Alberta Piping Plover Recovery Team 2010, Prescott *et al.* 2010).

Other Threats

Other threats to Piping Plovers in Canada include extreme high tides; long periods of rain following hatching; diseases/pathogens such as avian botulism, West Nile Virus and *Salmonella*; pollution; and oil spills (Boyne in press, Environment Canada 2012). On the species' coastal migration and wintering grounds, other threats include oil spills and other contaminants, and land-based oil and gas exploration and development; threats from military operations and disease appear to be minimal (USFWS 2012a).

PROTECTION, STATUS, AND RANKS

Legal Protection and Status

The Piping Plover is protected by the *Migratory Birds Convention Act 1994*. In Canada, the *Migratory Birds Convention Act* prohibits the destruction, disturbance or collection of the birds and their nests and eggs. Both subspecies of Piping Plover are listed as Endangered under Schedule 1 of Canada's *Species at Risk Act* (SARA), which protects the species, its residences (nests) and its critical habitat on federal lands. A recovery strategy for the interior subspecies was published in 2006 (Environment Canada 2006), and a recovery strategy for the eastern subspecies was published in 2012 (Environment Canada 2012). Draft action plans have been completed for the interior subspecies in Alberta, Saskatchewan and Manitoba, and an action plan for Ontario has been finalized. A residence description for both subspecies was completed in 2005, and critical habitat has been identified for both subspecies (Government of Canada 2012a, 2012b; see Habitat Protection and Ownership section).

The interior subspecies is protected as Endangered under the *Endangered Species Acts* of Manitoba and Ontario and the Saskatchewan and Alberta *Wildlife Acts*. It is also protected under the *Canada National Parks Act* where it is found in Point Pelee National Park during migration. The eastern subspecies occurs in several national parks and historic sites, where it is protected by the *Canada National Parks Act*. It is also protected in Quebec as Threatened under the *Loi sur les espèces menacées ou vulnérables* (RLRQ, c E-12.01) (LEMV) (Act respecting threatened or vulnerable species) (CQLR, c E-12.01) (MRNF 2011), and as Endangered under the New Brunswick, Newfoundland and Labrador, and Nova Scotia *Endangered Species Acts*. Prince Edward Island is reviewing the status of the species (Environment Canada 2012).

The Piping Plover is listed as Threatened under the US *Endangered Species Act* through most of its range, with the exception of the subpopulation found within the Great Lakes watershed, which is listed as Endangered (USFWS 2012b).

Non-Legal Status and Ranks

The Piping Plover is listed as Near Threatened on the IUCN Red List of Threatened Species (IUCN 2011). The assessment, dated 2008, notes that, although the population had increased overall since 1991 as a result of intensive conservation efforts, the species was still dependent on intensive management and would warrant immediate uplisting back to a status of Vulnerable if conservation efforts ceased or population trends reversed (BirdLife International 2008).

NatureServe (2012) lists the global rank of Piping Plover as G3 – Vulnerable (as of 11 January 2001, last reviewed 23 December 2004). The national ranks are N3 for both the breeding and non-breeding populations in the US, and N2B (breeding population Imperilled) in Canada (as of 22 January 2001). Within Canada, populations in Alberta and New Brunswick are also ranked as Imperilled (S2B), with populations in Manitoba, Ontario, Quebec, Newfoundland Island, Nova Scotia and Prince Edward Island ranked as Critically Imperilled (S1B). Saskatchewan ranks Piping Plovers as Vulnerable (S3B).

The general status rank for Piping Plover in Canada as a whole and all provinces in which it is found is "at risk". It is also listed as "accidental" in BC (Canadian Endangered Species Conservation Council 2012).

Habitat Protection and Ownership

Plovers benefit from federal habitat protection within national parks, migratory bird sanctuaries and federal national wildlife areas, as well as in areas designated as critical habitat under the *Species at Risk Act*, and from varying levels of habitat protection within provincial parks (while many are too heavily used to provide effective habitat for Piping Plovers, approximately half of the recent increase in abundance in Ontario has taken place in provincial parks). Piping Plover habitat is afforded protection under Ontario's *Endangered Species Act*, and habitat on the Magdalen Islands, QC, is in the process of receiving legal protection (Gauthier pers. comm. 2012).

Considerable effort has gone into the identification and designation of critical habitat across the US and Canadian range of the Piping Plover (Gratto-Trevor and Abbott 2011). For the interior subspecies in Canada, critical habitat was identified in 65 quarter sections in 20 basins in an addendum to the recovery strategy (Environment Canada 2007). The recovery strategy for the eastern subspecies (Environment Canada 2012) identified 212 sites with critical habitat.

Several Piping Plover nesting areas across Canada are internationally recognized as endangered species sites under the Western Hemisphere Shorebird Reserve Network (Bay of Fundy, Beaverhill Lake, Chaplin/Old Wives/Reed Lakes, Last Mountain Lake NWA, Quill Lakes; Western Hemisphere Shorebird Reserve Network 2009) or as Ramsar sites (Beaverhill Lake, Chignecto, Delta Marsh, Grand Codroy Estuary, Last Mountain Lake, Long Point, Malpeque Bay, Musquodoboit Harbour, Quill Lakes, Shepody Bay, Tabusintac Lagoon and River Estuary; The Ramsar Convention on Wetlands 2000); however, these designations do not confer any legal habitat protection (Goossen *et al.* 2002). Non-governmental and governmental organizations have contributed significantly to habitat protection in the Ontario Great Lakes, Quebec and Atlantic Canada since the early 1990s through guardian programs, which include education of beach users and coastal landowners and direct nest protection measures. Organizations such as Nature Conservancy of Canada have purchased land in order to protect habitat important to Piping Plovers.

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

Environment Canada funded the preparation of this report. F.H. Bell prepared the original status report, and S. Haig and A. Boyne prepared previous update reports. The author thanks them and the authorities listed below. The report benefited greatly from comments from D. Amirault-Langlais, K. Baker, M. Bidwell, R. Boles, N. Boucher, A. Boyne, V. Brownell, A. Calvert, G. Donaldson, S. Eaton, E. Herdman, V. Friesen, M. Gahbauer, I. Gauthier, C. Gratto-Trevor, R. Gutsell, D. Irwin, J. Keith, M. Leonard, A. Lévesque, J. McKnight, P. Nantel, M-F. Noel, C. Pelletier, K. Potter, C. Poussart, D. Prescott, C. Risley, J. Rock, M. Sabine, F. Shaffer, K. St. Laurent, J. Tremblay and S. Westworth. Special thanks to M. Leonard, to C. Gratto-Trevor and L. Engley for support and information out west and to S. Abbott, A. Boyne, J. Rock, J. McKnight for the same out east. A. Calvert and C. Gratto-Trevor also applied recent data to model a projected population trajectory for the interior subspecies, and I appreciate all of their work. Many thanks to Alain Filion and Pete Blancher (Environment Canada) for mapping and GIS analytical services, to K. Timm and J. Perrault, and to Judie Shore for use of her line drawing. The report writer would like to also thank her family.

Authorities Contacted

Jeff Robinson, Canadian Wildlife Service, London, ON

Francois Shaffer, Canadian Wildlife Service, Québec, QC

Jen Rock, Canadian Wildlife Service, Sackville, NB

Andrew Boyne, Canadian Wildlife Service, Halifax, NS

Michel Gosselin, Canadian Museum of Nature (Federal Biodiversity Information Partnership), Ottawa, ON

Patrick Nantel, Briar Howes, Parks Canada, Gatineau, QC

Deborah Austin, Parks Canada, Halifax, NS

Dean Nernberg, National Defence, Ottawa, ON

Dave Prescott, Fish and Wildlife Division, Environment and Sustainable Resource Development, Red Deer, AB

Ken Porteous, Portage la Prairie, MB

Vivian Brownell, Ontario Ministry of Natural Resources, Peterborough, ON

Annie Levesque, Isabelle Gauthier, Claudel Pelletier, Junior A. Tremblay and Catherine Poussart, Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs du Québec, Faune Québec, Québec, QC

Rosemary Curley, PEI Department of Environment, Energy and Forestry, Charlottetown, PE

Jeff Keith, Saskatchewan Conservation Data Centre, Regina, SK

Ben Sawa, Saskatchewan Conservation Data Centre, Regina, SK

Patricia Workman, Ontario Natural Heritage Information Centre, Peterborough, ON

Annie Paquet, Centre de données sur le patrimoine naturel du Québec, Québec, QC

Sean Blaney, Atlantic Canada Conservation Data Centre, Sackville, NB

Neil Jones, CWS, Gatineau, QC

Mary Sabine, New Brunswick Department of Natural Resources, Fredericton, NB

Peter Blancher, Environment Canada, Ottawa, ON

Alain Filion, Environment Canada, Gatineau, QC

Paul Goossen, Environment Canada (Emeritus), Winnipeg, MB

Cheri Gratto-Trevor, Environment Canada, Saskatoon, SK

Lance Engley, Alberta Conservation Association, Sherwood Park, AB

Sue Abbott, Bird Studies Canada, Dartmouth, NS.

CITES-listed species database: http://www.cites.org

IUCN Red List: www.redlist.org/

US Fish and Wildlife Service: http://www.fws.gov/endangered/

INFORMATION SOURCES

Abbott, S., pers. comm. 2011. *Email correspondence to N. Sharp.* November 2011. Nova Scotia Projects Coordinator, Bird Studies Canada, Dartmouth, NS.

Abbott, S., pers. comm. 2012. *Telephone conversation with N. Sharp.* June 2012. Nova Scotia Projects Coordinator, Bird Studies Canada, Dartmouth, NS.

Alberta Piping Plover Recovery Team. 2010. Alberta Piping Plover Recovery Plan, 2010-2020. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Recovery Plan No. 18. Edmonton, AB. 28 pp.

Amirault, D.L., F. Shaffer, K. Baker, A. Boyne, A. Calvert, J. McKnight, and P. Thomas. 2005. Preliminary results of a five year banding study in eastern Canada: support for expanding conservation efforts to non-breeding sites? In: Rabon, D.R. (compiler). 2006. Proceedings of the Symposium on the Wintering Ecology and Conservation of Piping Plovers. U.S. Fish and Wildlife Service, Raleigh, NC. Web site: http://www.fws.gov/raleigh/pdfs/ES/Amirault_Article.pdf [accessed 18 June 2012].

Austin-Smith, P.J., S.P. Flemming, C. Drysdale, and R.G. Williams. 1994. The 1991 Piping Plover census in Nova Scotia. Pp. 11–15 in Flemming, S.P. (ed.). The 1991 International Piping Plover Census in Canada. Canadian Wildlife Service, Occasional Paper 82. 59 pp.

Barber, C., A. Nowak, K. Tulk, and L. Thomas. 2010. Predator exclosures enhance reproductive success but increase adult mortality of Piping Plovers (*Charadrius melodus*). Avian Conservation and Ecology 5(2): 6. Web site: http://www.ace-eco.org/vol5/iss2/art6/

Bell, F.H. 1978. COSEWIC status report on the Piping Plover *Charadrius melodus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 45 pp.

Bidwell, M., pers. comm. 2012. *Editorial comments to N. Sharp.* September 2012. Species at Risk Biologist, Canadian Wildlife Service, Environment Canada, Saskatoon, SK.

BirdLife International. 2008. *Charadrius melodus.* In: IUCN. 2011. IUCN Red List of Threatened Species. Version 2011.2. Web site: www.iucnredlist.org [accessed 6 April 2012].

Blancher, P., pers. comm. 2011. *Email correspondence to N. Sharp.* November 2011. Research Scientist, Environment Canada, Ottawa, ON.

Blancher, P., pers. comm. 2013. *Email correspondence to N. Sharp.* September 2013. Research Scientist, Environment Canada, Ottawa, ON.

Boates, J.S., P. Austin-Smith, G. Dickie, R. Williams, and D. Sam. 1994. Nova Scotia Piping Plover atlas. Unpublished Nova Scotia Department of Natural Resources report. 86 pp.

Boucher, N., pers. comm. 2013. *Editorial comments to N. Sharp.* September 2013. Species at Risk Biologist, Ontario Ministry of Natural Resources, Sudbury, ON.

Boyne, A., pers. comm. 2013. *Email correspondence to N. Sharp.* September 2013. Species at Risk Biologist, Canadian Wildlife Service, Dartmouth, NS.

Boyne, A. In press (2001). Update COSEWIC status report on the Piping Plover *circumcinctus* subspecies (*Charadrius melodus circumcinctus*) and the *melodus* subspecies *(Charadrius melodus melodus*) in Canada, *in* COSEWIC assessment and update status report on the Piping Plover *circumcinctus* subspecies (*Charadrius melodus circumcinctus*) and the *melodus* subspecies *(Charadrius melodus melodus*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1–33 pp.

Boyne, A.W., and D.L. Amirault. 1999. Habitat characteristics of Piping Plover nesting beaches in Nova Scotia, New Brunswick, and Prince Edward Island. Pages 84-85 *in* Higgins, K.F., M.R. Brashier, and C.D. Kruse (eds.). Proceedings, Piping Plovers and Least Terns of the Great Plains and nearby. Brookings: South Dakota State University. 132 pp.

Burger, J. 1987. Physical and social determinants of nest site selection in Piping Plovers in New Jersey. Condor 89: 881–918.

Cairns, W.E. 1977. Breeding biology and behaviour of the Piping Plover (*Charadrius melodus*) in southern Nova Scotia. M.Sc. thesis, Dalhousie University, Halifax, Nova Scotia. 100 pp. plus appendices.

Calvert, A.M., and C.L. Gratto-Trevor, pers. comm. 2012. *Email correspondence to N. Sharp*. October 2012. Independent biology consultant, Montreal, QC (Calvert); Research Scientist Shorebirds, Environment Canada, Saskatoon, SK (Gratto-Trevor).

Calvert, A. M., and P.D. Taylor. 2011. Measuring conservation trade-offs: demographic models provide critical context to empirical studies. Avian Conservation and Ecology 6(2): 2. Web site: http://dx.doi.org/10.5751/ACE-00470-060202

Calvert, A.M., D.L. Amirault, F. Shaffer, R. Elliot, A. Hanson, J. McKnight, and P.D. Taylor. 2006. Population assessment of an endangered shorebird: the Piping Plover (*Charadrius melodus melodus*) in Eastern Canada. Avian Conservation and Ecology 1(3):4.

Canadian Endangered Species Conservation Council. 2012. Wild Species: The General Status of Species in Canada. National General Status Working Group. Web site: http://www.wildspecies.ca/ [accessed April 2012].

Cohen, J.B., and C. Gratto-Trevor. 2011. Survival, site fidelity, and the population dynamics of Piping Plovers in Saskatchewan. Journal of Field Ornithology 82(4):379–394.

Daigle, R., D. Forbes, G. Parkes, H. Ritchie, T. Webster, D. Bérubé, A. Hanson, L. DeBaie, S. Nichols, and L. Vasseur (eds.). 2006. Impacts of Sea-Level Rise and Climate Change on the Coastal Zone of Southeastern New Brunswick. Environment Canada. 611 pp.

Elliott-Smith, E. and S. M. Haig. 2004. Piping Plover (*Charadrius melodus*), The Birds of North America Online (A. Poole, ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/002

Elliott-Smith, E., S.M. Haig, and B.M. Powers. 2009. Data from the 2006 International Piping Plover Census. U.S. Geological Survey Data Series 426. Available from http://pubs.usgs.gov/ds/426/

Environment Canada. 2006. Recovery strategy for the Piping Plover (*Charadrius melodus circumcinctus*) in Canada. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa, ON. vi + 30 pp.

Environment Canada. 2007. Addendum to the final recovery strategy for the Piping Plover (*Charadrius melodus circumcinctus*) in Canada RE: identification of critical habitat. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa, ON. 12 pp.

Environment Canada. 2012. Recovery strategy for the Piping Plover (*Charadrius melodus melodus*) in Canada. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa, ON. v + 29 pp.

Environment Canada. 2013. Action Plan for the Piping Plover (*Charadrius melodus circumcinctus*) in Ontario. *Species at Risk Act* Action Plan Series. Environment Canada, Ottawa, ON. iii + 20 pp.

Espie, R.H.M., R.M. Brigham, and P.C. James. 1996. Habitat selection and clutch fate of Piping Plovers (*Charadrius melodus*) breeding at Lake Diefenbaker, Saskatchewan. Canadian Journal of Zoology 74:1069–1075.

Flemming, S.P., R.D. Chiasson, P.C. Smith, P.J. Austin-Smith, and R.P. Bancroft. 1988. Piping Plover status in Nova Scotia related to its reproductive and behavioral responses to human disturbance. Journal of Field Ornithology 59:321–330.

Flemming, S.P., R.D. Chiasson, and P.J. Austin-Smith. 1992. Piping Plover nest site selection in New Brunswick and Nova Scotia. Journal of Wildlife Management 56:578–583.

Funk, W.C., T.D. Mullins, and S.M. Haig. 2007. Conservation genetics of Snowy Plovers (*Charadrius alexandrinus*) in the Western Hemisphere: Population genetic structure and delineation of subspecies. Conservation Genetics 8:1287–1309.

Gauthier, I., pers. comm. 2012. *Editorial comments to N. Sharp.* September 2012. Coordonnatrice provinciale, espèces fauniques menacées et vulnérables, Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs du Québec, Faune Québec, Québec, QC.

Gautreau, R.L. 1998. Budgets temporels et énergétiques des pluviers siffleurs et utilisation des composantes de l'habitat au Parc National de L'Île-du-Prince-Édouard. M.Sc. thesis. Université de Moncton. Moncton, NB.

Goldin, M.R., and J.V. Regosin. 1998. Chick behavior, habitat use, and reproductive success of Piping Plovers at Goosewing Beach, Rhode Island. Journal of Field Ornithology 69:228–234.

Goossen, J.P., and D.L. Amirault-Langlais (eds.). 2010. The 2006 International Piping Plover Census in Canada. Technical Report Series No. 490. Canadian Wildlife Service (Environment Canada), Edmonton, Alberta and Sackville, New Brunswick. 139 pp. plus an appendix.

Goossen, J.P., D.L. Amirault, S. Richard, R. Bjorge, J. Brazil, S. Brechtel, R. Chiasson, G.N. Corbett, F.R. Curley, M. Elderkin, S.P. Flemming, W. Harris, L. Heyens, D. Hjertaas, M. Huot, R. Jones, W. Koonz, P. Laporte, R.I.G. Morrison, C. Stewart, L. Swanson, and E. Wiltse. 2002. National recovery plan for the Piping Plover (*Charadrius melodus*). National Recovery Plan No. 22. Recovery of Nationally Endangered Wildlife. Ottawa. 47 pp.

Government of Canada. 2012a. Species profile Piping Plover *circumcinctus* subspecies. URL: http://www.registrelep-sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=27 [accessed 24 April 2012].

Government of Canada. 2012b. Species profile Piping Plover *melodus* subspecies. URL: http://www.registrelep-sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=687 [accessed 6 April 2012].

Gratto-Trevor, C.L., pers. comm. 2012. *Editorial comments to N. Sharp.* September 2012. Research Scientist Shorebirds, Environment Canada, Saskatoon, SK.

Gratto-Trevor, C.L., and S. Abbott. 2011. Conservation of Piping Plover (*Charadrius melodus*) in North America: science, successes, and challenges. Canadian Journal of Zoology 89:401–418.

Gratto-Trevor, C.L., J.P. Goossen, and S.M. Westworth. 2010. Identification and breeding of yearling Piping Plovers. Journal of Field Ornithology 81(4):383–391.

Gratto-Trevor, C., D. Amirault-Langlais, D. Catlin, F. Cuthbert, J. Fraser, S. Maddock, E. Roche, and F. Shaffer. 2012. Connectivity in Piping Plovers: Do breeding populations have distinct winter distributions? Journal of Wildlife Management 76(2):348–355.

Grinsted, A., J.C. Moore, and S. Jevrejeva. 2012. Homogeneous record of Atlantic hurricane surge threat since 1923. Proceedings of the National Academy of Sciences of the United States of America 109(48):19601–19605. doi:10.1073/pnas.1209542109.

Haig, S.M. 1992. Piping Plover. *In* The Birds of North America, No. 2 (A. Poole, P. Stettenheim, and F. Gill, eds.). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union.

Haig, S.M., and L.W. Oring. 1988. Genetic differentiation of Piping Plovers across North America. Auk 105:260–267.

Haig, S.M., and J.H. Plissner. 1993. Distribution and abundance of Piping Plovers: results and implications of the 1991 international census. Condor 95:145–156.

Harris, W.C., D.C. Duncan, R.J. Franken, D.T. McKinnon, and H.A. Dundas. 2005. Reproductive success of Piping Plovers at Big Quill Lake, Saskatchewan. Wilson Bulletin 117: 165–171.

Herdman, E., pers. comm. 2012. *Editorial comments to N. Sharp.* September 2012. Ecosystem Management Ecologist, Endangered Species, Wildlife Division, Department of Environment and Conservation, Government of Newfoundland and Labrador, St. John's, NL.

Herdman, E., pers. comm. 2013. *Editorial comments to N. Sharp.* September 2013. Ecosystem Management Ecologist, Endangered Species, Wildlife Division, Department of Environment and Conservation, Government of Newfoundland and Labrador, St. John's, NL.

Hillman, M.D., S.M. Karpanty, J.D. Fraser, F.J. Cuthbert, J.M. Altman, T.E. Borneman, and A. Derose-Wilson. 2012. Evidence for long-distance dispersal and successful interpopulation breeding of the endangered Piping Plover. Waterbirds 35(4):642–644.

Hull, C. 1981. Great Lakes Piping Plover in trouble. Michigan Department of Natural Resources, Lansing, Michigan. 2 pp.

IUCN. 2011. IUCN Red List of Threatened Species. Version 2011.2. Web site: www.iucnredlist.org [accessed 6 April 2012].

Knetter, J.M., R.S. Lutz, J.R. Cary, and R.K. Murphy. 2002. A multi-scale investigation of Piping Plover productivity on Great Plains alkali lakes, 1994–2000. Wildlife Society Bulletin 30:683–694.

Loegering, J.P., and J.D. Fraser. 1995. Factors affecting Piping Plover chick survival in different brood-rearing habitats. Journal of Wildlife Management 59:646–655.

McKnight, J., pers. comm. 2011. *Email correspondence to N. Sharp*. November 2011. Senior Species at Risk Biologist, Canadian Wildlife Service, Dartmouth, NS.

McKnight, J., pers. comm. 2013. *Email correspondence to N. Sharp*. September 2013. Species at Risk Biologist, Canadian Wildlife Service, Dartmouth, NS.

Melvin, S.M., and J.P. Gibbs. 1994. Viability analysis for the Atlantic Coast population of Piping Plovers. Unpublished report to the United States Fish and Wildlife Service, Sudbury, Massachusetts. Pages 175-186 *in* United States Fish and Wildlife Service. 1996. Piping Plover (*Charadrius melodus*), Atlantic Coast Population, Revised Recovery Plan. Hadley, Massachusetts. 258 pp.

Miller, M.P., S.M. Haig, C.L. Gratto-Trevor, and T.D. Mullins. 2010. Subspecies status and population genetic structure in Piping Plover (*Charadrius melodus*). Auk 127(1):57–71.

Murphy, R.K., I.M.G. Michaud, D.R.C. Prescott, J.S. Ivan, B.J. Anderson, and M.L. French-Pombier. 2003. Predation on adult Piping Plovers at predator exclosure cages. Waterbirds 26:150–155.

NatureServe. 2012. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Web site: http://www.natureserve.org/explorer [accessed 6 April 2012].

Plissner, J.H., and S.M. Haig. 2000a. Status of a broadly distributed endangered species: results and implications of the second International Piping Plover Census. Canadian Journal of Zoology 78:128–139.

Plissner, J.H., and S.M. Haig. 2000b. Viability of Piping Plover *Charadrius melodus* metapopulations. Biological Conservation 92: 163–173.

Porteous, K., pers. comm. 2011. *Email correspondence to N. Sharp*. December 2011. Coordinator of the 2011 International Piping Plover Breeding Census, Portage Natural History Group, Portage la Prairie, MB.

Prescott, D.R.C., pers. comm. 2011. *Email correspondence to N. Sharp*. September 2011. Species at Risk Biologist, Ministry of Sustainable Resource Development, Government of Alberta, Red Deer, AB.

Prescott, D.R.C., pers. comm. 2013. *Email correspondence to N. Sharp*. September 2013. Species at Risk Biologist, Ministry of Sustainable Resource Development, Government of Alberta, Red Deer, AB.

Prescott, D. R. C., L. C. Engley, and D. Sturgess. 2010. Implementation of the *Alberta Piping Plover Recovery Plan, 2005-2010:* Final Program Report. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 129, Edmonton, AB. 27 pp.

Prindiville Gaines, E.M., and M.R. Ryan. 1988. Piping Plover habitat use and reproductive success in North Dakota. Journal of Wildlife Management 52:266–273.

Prugh, L.R., C.J. Stoner, C.W. Epps, W.T. Bean, W.J. Ripple, A.S. Laliberte, and J.S. Brashares. 2009. The rise of the mesopredator. BioScience 59(9):779–791. doi:10.1525/bio.2009.59.9.9

Ranalli, M., pers. comm. 2011. *Email correspondence to N. Sharp.* December 2011. Species at Risk Manager, Nature Saskatchewan, Regina, SK.

Richardson, I.M.G. 1999. Predator exclosures: a management technique to increase Piping Plover (*Charadrius melodus*) reproductive success in the Canadian prairies. MSc. Thesis, University of Alberta, Edmonton, AB. 65 pp.

Ridgely, R.S., T.F. Allnutt, T. Brooks, D.K. McNicol, D.W. Mehlman, B.E. Young, and J.R. Zook. 2007. Digital Distribution Maps of the Birds of the Western Hemisphere, version 3.0. NatureServe, Arlington, Virginia, USA.

Rioux, S., D.L. Amirault-Langlais, and F. Shaffer. 2011. Piping Plovers make decisions regarding dispersal based on personal and public information in a variable coastal ecosystem. Journal of Field Ornithology 82(1):32–43.

Robinson, J., pers. comm. 2011. *Email correspondence to N. Sharp.* December 2011. Protected Areas Coordinator, Canadian Wildlife Service, London, ON.

Roche, E.A., T.W. Arnold, and F.J. Cuthbert. 2010a. Apparent nest abandonment as evidence of breeding-season mortality in Great Lakes Piping Plovers (*Charadrius melodus*). Auk 127(2):402–410.

Roche, E.A., J.B. Cohen, D.H. Catlin, D.L. Amirault-Langlais, F.J. Cuthbert, C.L. Gratto-Trevor, J. Felio, and J.D. Fraser. 2010b. Range-wide Piping Plover survival: correlated patterns and temporal declines. Journal of Wildlife Management 74(8):1784–1791.

Roche, E.A., C.L. Gratto-Trevor, J.P. Goossen, and C.L. White. 2012. Flooding affects dispersal decisions in Piping Plovers (*Charadrius melodus*) in Prairie Canada. Auk 129(2):296–306.

Rock, J., pers. comm. 2012. *Email correspondence and data file to N. Sharp.* November 2012. Wildlife Biologist, Canadian Wildlife Service, Environment Canada, Government of Canada, Sackville, NB.

Rock, J. 2011. Piping Plover in Eastern Canada — Regional Summary 2011. Internal report, Canadian Wildlife Service, Sackville, NB.

Rock, J. 2013. 2012 regional overview — Piping Plover. Internal report, Canadian Wildlife Service, Sackville, NB.

St. Laurent, K., pers. comm. 2012. *Editorial comments to N. Sharp.* September 2012. Species at Risk Biologist, Ecosystem Conservation, Canadian Wildlife Service, Environment Canada, Downsview, ON.

St. Laurent, K., pers. comm. 2013. *Editorial comments to N. Sharp*. September 2013. Species at Risk Biologist, Ecosystem Conservation, Canadian Wildlife Service, Environment Canada, Downsview, ON.

The Ramsar Convention on Wetlands. 2000. The annotated Ramsar list: Canada. Web site: http://www.ramsar.org/cda/en/ramsar-pubs-notes-anno-canada/main/ramsar/1-30-168^16491_4000_0__ [accessed 18 June 2012].

US Fish and Wildlife Service (USFWS). 1996. Piping Plover (*Charadrius melodus*), Atlantic Coast Population, Revised Recovery Plan. U.S. Fish and Wildlife Service. Hadley, Massachusetts. 258 pp.

U.S. Fish and Wildlife Service (USFWS). 2012a. Comprehensive conservation strategy for the Piping Plover (*Charadrius melodus)* in its coastal migration and wintering range in the continental United States. East Lansing, Michigan. vi + 115 pp.

US Fish and Wildlife Service (USFWS). 2012b. Piping Plover (*Charadrius melodus*). Web site: http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B079 [accessed 6 April 2012].

Wentzell, N. 1997. Piping Plover habitat manipulation proposal. Unpublished report, Kejimkujik National Park Seaside Adjunct. 29 pp.

Western Hemisphere Shorebird Reserve Network. 2009. WHSRN List of sites. Web site: http://www.whsrn.org/sites/list-sites [accessed 18 June 2012].

Westworth, S.M., D. Martens, C.L. Gratto-Trevor, J.P. Goossen, and S. Davis. 2004. Northern Great Plains Piping Plover Science Workshop: 20–23 November 2003, Regina Saskatchewan. Unpublished Canadian Wildlife Service report, Edmonton, Alberta. 58 pp.

Wilcox, L. 1959. A twenty year banding study of the Piping Plover. Auk 76:129–152.

BIOGRAPHICAL SUMMARY OF REPORT WRITER

Nyree Sharp has worked with Alberta's Fish and Wildlife Division (Department of Sustainable Resource Development) and the Alberta Conservation Association on a variety of species at risk projects since early 2001. For the Alberta Conservation Association she acted as series editor for Alberta's detailed status reports on species at risk (analogous to COSEWIC's status reports), as part of the status assessment process. Her work for Alberta's Fish and Wildlife Division has included reviewing environmental impact assessments and writing, editing and reviewing various species at risk project and summary reports, fact sheets and technical summaries. She has also taught an introductory biology course and ecology lab at Grant MacEwan College. She completed her B.Sc. (Honours) in Environmental Biology at the University of Alberta and her M.Sc. in Conservation Biology at the University of British Columbia. Her thesis examined the predicted effects of logging on bird habitat in the aspen boreal mixedwood.

COLLECTIONS EXAMINED

None.